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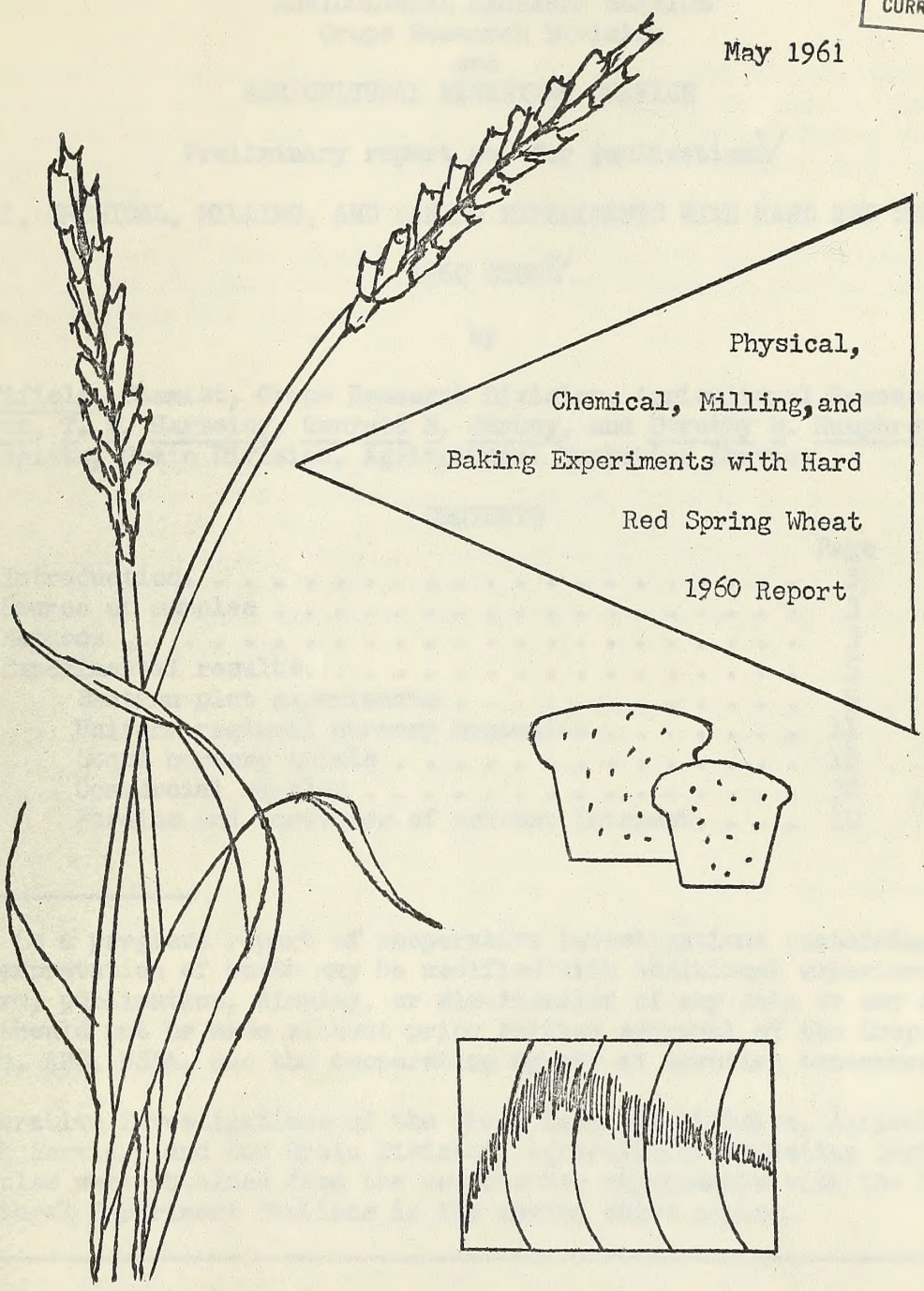
May 1961



Physical, Chemical, Milling, and Baking Experiments with Hard Red Spring Wheat

1960 Report

United States Department of Agriculture
Agricultural Research Service
Crops Research Division

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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Crops Research Division
and
AGRICULTURAL MARKETING SERVICE

Preliminary report not for publication[1/]

PHYSICAL, CHEMICAL, MILLING, AND BAKING EXPERIMENTS WITH HARD RED SPRING WHEAT

1960 CROP[2/]

by

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1/ This is a progress report of cooperative investigations containing data, the interpretation of which may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or any statements herein should not be made without prior written approval of the Crops Research Division, ARS, USDA, and the cooperating agency or agencies concerned.

2/ Cooperative investigations of the Crops Research Division, Agricultural Research Service, and the Grain Division, Agricultural Marketing Service. The samples were obtained from the cooperative experiments with the State Agricultural Experiment Stations in the spring wheat region.

Plant Industry Station
Beltsville, Maryland
CR-35-61

INTRODUCTION

Samples of the standard varieties and many of the new strains of hard red spring wheat grown in cooperative experiments in the spring wheat region of the United States[3] are milled each year by the United States Department of Agriculture and the flours baked into bread to determine their quality characteristics.

The purpose of this report is to make available to cooperators the quality data on standard varieties, new strains, and commercial hard red spring wheat from the 1960 crop.

SOURCE OF SAMPLES

Tests were made on composite and individual samples of the uniform varieties and many other varieties and strains grown in plot experiments at cooperating stations. These included samples grown at Madison, Wisconsin, and at Morris, Rosemount, Waseca, and Crookston, Minnesota. Similar tests were made on Eastern and Western composites of the 27 strains of wheat grown in the uniform regional nurseries and on the wheats from the station nurseries in Wisconsin and Montana.

There were also included 25 samples composited by grade from samples of carlot receipts of wheat accumulated during a 90-day period of the 1960 crop movement by the Minneapolis, Duluth, and Great Falls offices of the Grain Division. These samples represent country-run receipts of the class hard red spring wheat and included only those lots that were graded No. 5 or better under the Official Grain Standards of the United States. These hereafter are referred to as commercial samples. This is the twenty-second season that such samples have been collected and tested.

METHODS

Methods used for the 1960 crop material were the same as those summarized in the 1959 report and will not be repeated here. The only exception to this was the employment in 1960 of the remix straight dough bread-baking method[4] which was developed at the Canadian Grain Research Laboratory, Winnipeg, Canada. This method is based on a formula using 100 grams of flour, 3.0 grams of compressed yeast, 2.5 grams of sugar, 1 gram of salt, 15 parts per million of potassium bromate, 0.1 grams ammonium phosphate, and 0.3 grams of 275° Litner malt syrup. The doughs were mixed

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3/ Ausemus, E. R. Results on spring wheat varieties grown in cooperative plot and nursery experiments in the spring wheat region in 1960. U. S. Department of Agriculture, Agricultural Research Service, Crops Research Division, CR-10-61, 77 pp., University Farm, St. Paul, Minn. (Processed). January 1961.

4/ Irvine, G. N. and McMullan, Marion E. The "remix" baking test. Cereal Chem. 37: 603-613 (1960).

in a mixer (108 r.p.m.) for 2.0 minutes and fermentated for two hours 45 minutes at 86°F. Without punching, the doughs were remixed at the same speed for 1 minute, 20 seconds. After a recovery period of 25 minutes, the doughs were moulded, proofed for 55 minutes at 86° and baked 25 minutes at 440°.

The results of this bread-baking method are shown in the tables in comparison with the quality results obtained by our regular bread-baking method used since 1944 in the Beltsville laboratory. It is claimed that the remix procedure is a better measure of strength of exceptionally strong wheats, while showing up weaknesses of the medium strong and weak types. Thus, the remix method appears to provide a wider differentiation of loaf volumes than can be obtained with our regular baking method. A limited study last year of wheats of different protein contents and baking strengths indicated, in general, that the strong wheats produced higher loaf volumes and better internal bread characteristics, whereas while the weak wheats were lower in loaf volume and had poorer internal properties by the remix method than by our regular Beltsville bread-baking method.

Bread loaf volume must be adequate for the protein content of the flour if the variety is to be considered satisfactory. The loaf volumes are shown in the tables on an "as is" protein basis and, in addition, on an expected loaf volume basis. The expected loaf volume based on flour protein content is the loaf volume obtained from baking experiments in which the flour from 589 samples of 10 hard red spring wheat varieties was tested for the crop years 1944 to 1947. The higher "as is" loaf volumes generally are associated with superior bread-baking strength.

A check or standard flour (13.3 percent protein and 0.52 percent ash on a 14.0 percent moisture basis) was included in the baking trials with each day's test. The average volume of the loaves made with the standard flour was 843 cc. and the standard error was 26.4 cc. On this basis the least significant difference between 2 single bakes was 53 cc.

The quality properties of each variety with respect to crumb grain and color of the bread are shown numerically in the tables. The following scores may be used as an index for judging these two properties:

59 or below	Very poor or unsatisfactory
60 to 69	Poor or questionable
70 to 79	Fair
80 to 89	Good
90 to 100	Very good

Varieties or selections having loaf volumes approximately 125 cc. less than expected, as based on the flour protein content, are questionable; and those having loaf volumes less by approximately 200 cc. or more are unsatisfactory.

An unsatisfactory rating on one or more of the properties would indicate that the variety or strain is generally undesirable for hard wheat milling or bread-making purposes except that a questionable rating on one or more of the quality properties may be balanced by other outstanding properties. The milling properties are discussed in the text and should be considered along with the bread-baking properties.

EXPERIMENTAL RESULTS

Station Plot Experiments

The quality data for the uniform varieties and other wheats grown in plots are shown in table 1.

Wisconsin - Wheat samples were received only from Madison. The varieties and strains have made generally satisfactory bread considering the protein content of the wheats. The flour yields were exceptionally high in relation to the test weights of the grain, but flours with medium to high ash contents were obtained.

Conley was perhaps the best among the known varieties in overall quality but only slightly better in many respects than Selkirk and Canthatch. Henry was better than Lee and Thatcher for many of the quality properties tested with the exception of a higher pearling index and shorter mixing time. Thatcher and Canthatch had the lowest pearling index values (a desirable property) of the varieties. Conley was highest in protein content whereas Henry produced the highest flour yield of the uniform varieties. There were only small differences among the varieties in flour ash contents and water absorptions. Lee and Conley had slightly longer mixing times but loaves made from Selkirk and Henry were slightly larger in volume. Henry had excellent milling properties, whereas Selkirk and Conley scored very good, and Thatcher and Lee scored only good.

C.I. 12633 x Henry[2] (sel. 1-1) was similar in most respects to Henry. The wheat had slightly higher test weight (0.5 pounds) and protein content (0.7 percent) but lower flour yield (1.0 percent) and loaf volume (33 cc.) than Henry. The pearling index, water absorption, mixing time, oxidation requirement, crumb color, and grain scores were virtually the same for both. This wheat produced flour with the highest ash content (.63 percent) of the group but only slightly higher than Thatcher and Selkirk with .61 percent each. Bread made from this sample had acceptable loaf volume with satisfactory grain and color when compared with comparably-grown varieties. This cross milled only good and the dough at the time of panning was mellow and similar to Henry in this respect.

H515b-7-2-12-5 appeared to have many quality properties equal to or better than several of the uniform varieties. It had the lowest ash content and better test weight and flour yield than many of the others in this group. However, it also had the lowest protein content, water absorption, and loaf volume with only acceptable grain and crumb color. It was similar to Lee in many respects with a few exceptions such as slightly lower protein content, lower water absorption, and shorter mixing time but had better flour yield and lower ash content. This strain had excellent milling characteristics but produced bread dough that was mellow and slightly weak at panning time.

Table 1. -- Milling, baking, and chemical results for hard red spring wheats grown in replicated plots in 1960.

Variety or Cross	C.I. No.	Test Weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.
Madison, Wisconsin															
Henry	12265	59.2	33	12.9	11.6	77.8	.57	64	2.50	38	2	803	80	85	779
Thatcher	10003	59.9	24	12.7	11.9	74.3	.61	64	2.75	37	1	775	85	90	791
Lee	12488	60.8	28	12.8	11.5	73.6	.59	65	3.00	41	2	755	85	85	775
Selkirk	13100	59.2	29	13.2	12.8	76.9	.61	65	2.25	42	1	815	85	95	825
Conley	13157	59.2	27	13.9	13.0	75.6	.57	65	3.00	52	1	785	80	90	833
Canthatch	13345	60.5	25	12.9	12.2	74.6	.58	65	2.25	40	1	765	80	85	802
C.I. 12633 x Henry[2]	Sel 1-1	59.7	32	13.6	12.3	76.8	.63	64	2.25	41	2	770	75	85	806
H515b-7-2-12-5		60.0	29	12.5	11.2	76.8	.53	61	2.50	36	2	745	75	75	764
Lathrop (Wisc. 253)	13457	60.2	34	13.5	12.3	77.6	.55	61	2.25	48	1	820	90	85	806
K184 x Wis 250[4]	Sel 6-12	60.8	29	14.0	13.0	75.5	.60	63	2.25	43	2	803	70	80	833
Crookston, Minnesota															
Thatcher	10003	60.1	22	10.9	10.3	76.2	.57	61	3.75	28	1	725	65	70	730
Lee	12488	60.4	29	11.2	10.4	76.8	.52	62	3.00	29	2	688	80	75	734
Selkirk	13100	58.8	27	10.5	9.8	77.6	.59	60	2.75	29	2	725	75	85	710
Conley	13157	60.0	25	11.8	10.9	76.6	.53	66	3.75	38	2	775	85	90	752
Pembina	13332	58.5	24	11.5	10.5	74.5	.58	62	4.00	40	2	728	80	80	738
N.D. 81 x Lee	13349	60.0	28	10.9	10.1	76.9	.55	67	3.75	32	2	725	75	75	722
Conley x N.D. 40-2	13462	60.6	27	12.5	11.5	76.9	.49	67	3.50	48	1	785	75	70	775
II-44-29xLee[3]	13458	60.8	29	10.4	9.6	77.5	.48	66	3.75	33	1	710	70	70	703
II-44-29xLee[3]	13416	60.1	29	10.2	9.4	78.[illegible]	.50	67	4.00	31	1	735	70	75	696
KT-Tc[3]xII-44-29-Tc[2]	13465	60.0	27	10.5	9.6	75.6	.49	59	3.50	32	2	645	75	70	703
Ftn-Tc[3]xII-44-29-Tc[2]	13466	60.2	22	11.7	10.9	78.5	.52	63	3.50	40	2	765	85	95	752

Table 1. -- Continued.

Variety or Cross	C.I. No.	Test Weight[1]	Pearling index	Protein[2]		Flour Yield[3]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume
				Wheat	Flour										
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.
Waseca, Minnesota															
Thatcher	10003	58.0	23	13.3	12.4	77.2	.58	63	3.00	42	2	858	65	90	810
Lee	12488	60.0	27	14.6	13.9	76.5	.56	65	3.00	48	2	885	70	100	867
Selkirk	13100	57.7	33	15.3	14.6	76.5	.55	65	2.75	60	2	945	85	95	894
Conley	13157	57.2	27	14.5	13.7	76.8	.53	63	2.50	61	1	890	85	90	860
Pembina	13332	59.4	27	14.0	13.3	77.7	.57	61	3.75	67	2	808	70	85	844
N.D. 81 x Lee	13349	58.5	29	15.1	14.3	75.1	.62	68	2.75	44	2	955	80	95	882
II-44-29xLee^3	13458	59.7	30	14.3	13.5	76.5	.56	65	2.75	59	2	873	75	90	852
II-44-29xLee^3	13416	59.0	30	14.4	13.5	77.6	.56	68	2.75	58	1	883	75	100	852
KT-Tc^{3}xII-44-29-Tc^2	13465	59.0	26	14.3	13.5	76.3	.56	66	2.75	45	1	880	90	100	852
Ftn-Tc^{3}xII-44-29-Tc^2	13466	60.5	30	15.6	14.7	76.8	.56	67	2.00	65	2	930	95	100	898
Morris, Minnesota															
Thatcher	10003	56.1	31	12.5	11.6	76.0	.58	63	2.75	40	2	785	80	95	779
Lee	12488	55.6	34	13.8	12.6	73.8	.58	64	2.75	37	1	823	80	90	817
Selkirk	13100	54.7	36	12.6	11.7	77.1	.55	63	2.75	38	1	795	80	95	783
Conley	13157	54.5	32	13.5	12.4	74.7	.56	66	2.75	36	1	845	75	100	810
Pembina	13332	56.0	32	12.8	11.8	78.1	.56	62	4.25	50	2	765	80	90	787
N.D.81 x Lee	13349	54.0	32	13.5	12.3	75.1	.64	68	3.00	30	1	835	70	95	806
Conley x N.D. 40-2	13462	55.4	33	14.6	13.6	74.8	.53	68	3.50	45	1	863	75	95	856
II-44-29 x Lee^3	13458	55.8	36	13.2	12.1	78.3	.57	66	3.25	38	1	800	70	90	798
II-44-29 x Lee^3	13416	54.8	35	12.8	11.6	76.9	.53	67	3.25	36	1	800	80	90	779
KT-Tc^3 x II-44-29-Tc^2	13465	55.2	36	12.9	12.0	75.6	.50	67	3.50	37	1	810	80	90	794
Ftn-Tc^{3}xII-44-29-Tc^2	13466	56.7	31	14.0	12.9	75.4	.56	67	2.75	45	1	885	80	100	829

Table 1. — Continued

Variety or Cross	C.I. No.	Test Weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[2]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Quality of dough according to mixogram tests: Development time	Mixing tolerance	Remix baking data: Loaf vol	Crumb Color	Crumb Grain
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.	C.c.	Score	Score
Rosemount, Minnesota																				
Thatcher	10003	58.8	26	14.5	13.8	77.8	.62	66	2.50	55	1	958	75	100	863					
Lee	12488	59.5	31	16.0	15.0	73.8	.63	68	2.50	57	2	962	90	95	909					
Selkirk	13100	57.0	34	15.7	15.5	76.8	.64	63	2.50	64	1	950	70	100	928					
Conley	13157	56.0	29	16.1	15.4	78.3	.60	65	2.75	66	2	995	90	100	924					
Pembina	13332	58.6	29	15.7	15.3	76.4	.59	63	3.00	71	2	898	70	90	921					
N.D.81 x Lee	13349	59.2	32	16.4	15.5	74.8	.66	64	3.00	60	2	920	80	95	928					
Conley x N.D.40-2	13462	59.2	36	17.3	16.3	77.4	.57	65	2.50	70	2	1043	85	95	959					
II-44-29 x Lee[3]	13458	59.6	33	15.9	14.9	76.9	.57	64	2.00	67	1	925	70	100	905					
II-44-29 x Lee[3]	13416	58.2	32	15.8	14.7	77.0	.57	67	3.00	65	2	937	75	100	898					
KT-Tc[3]xII-44-29-Tc[2]	13465	59.0	29	15.5	14.8	77.9	.60	65	2.50	50	2	945	90	100	901					
Ftn-Tc[3]xII-44-29-Tc[2]	13466	60.0	32	16.5	15.8	76.5	.54	66	2.25	65	2	1040	90	100	940					
Average data for eleven varieties and strains from four Minnesota stations																				
Thatcher	10003	58.2	26	12.8	12.0	76.8	.59	63	3.00	41	1.5	832	71	89	796	3.75	3.50	865	70	90
Lee	12488	58.9	30	13.9	13.0	75.2	.57	65	2.81	43	1.8	840	80	90	832	3.00	2.50	885	75	80
Selkirk	13100	57.0	32	13.5	12.9	77.0	.58	63	2.69	48	1.5	854	78	94	829	2.75	2.00	875	85	95
Conley	13157	56.9	28	14.0	13.1	76.6	.56	65	2.94	50	1.5	876	84	95	836	3.25	3.25	923	85	90
Pembina	13332	58.1	29	13.5	12.7	76.7	.58	62	3.75	57	2.0	800	75	86	822	6.25	4.00	853	75	85
N.D.81 x Lee	13349	57.9	30	14.0	13.0	75.5	.62	67	3.12	42	1.8	859	76	90	834	3.00	2.25	895	80	85
Conley x N.D. 40-2[4]	13462	58.4	32	14.8	13.8	76.4	.53	67	3.17	41	1.3	897	78	87	863	3.50	4.75	983	80	100
II-44-29 x Lee[3]	13458	59.0	32	13.5	12.5	77.3	.54	65	2.94	49	1.2	827	71	88	814	3.50	3.00	915	80	85
II-44-29 x Lee[3]	13416	58.0	32	13.3	12.3	77.4	.54	67	3.25	48	1.2	848	75	91	806	4.25	3.25	935	80	85
KT-Tc[3]xII-44-29-Tc[2]	13465	58.3	30	13.3	12.5	76.4	.54	64	3.06	41	1.5	820	84	90	812	4.00	2.75	890	85	95
Ftn-Tc[3]xII-44-29-Tc[2]	13466	59.4	29	14.4	13.6	76.8	.54	66	2.63	47	1.8	905	88	99	855	2.50	2.50	970	75	85

1/ Dockage free
2/ 14.0 percent moisture basis
3/ Moisture free
4/ No sample from Waseca

Lathrop (Wis. 253, C.I. 13457) made exceptionally good bread considering the protein content of the flour. It was the only sample (other than Henry) to produce loaves of greater volume than the expected volume for a given protein content. It scored highest in crumb color and was the same as Selkirk and Canthatch in grain of the bread. This sample was similar to Selkirk in many of its quality characteristics but differed in pearling index, ash content, and water absorption. The pearling index (34 percent) was the highest of the group, indicative of a softer textured wheat as compared to 29 percent for Selkirk. A slightly lower ash content of .55 percent for Lathrop as compared to .61 percent for both Selkirk and Thatcher is a favorable property. The water absorption (61 percent) for this sample was one of the two lowest in the entire group. The mixing time was the same as that of Selkirk and Canthatch but not as long as that of Lee and Conley. This sample had excellent milling characteristics and produced a strong bread dough at the time of panning.

K184 x Wis. 250^{4} (sel. 6-12) was similar to Conley in nearly all of the properties tested. There were only slight differences in pearling index values, ash contents, water absorptions, oxidation requirements, loaf volumes, crumb colors, and grain scores. Conley had a longer dough mixing time and handled better in the milling process but sel. 6-12 was slightly better than Conley in test weight. However, the crumb color and grain of the bread from Conley scored slightly higher than that of sel. 6-12. This wheat was one of the highest in protein content of the group. The dough at the time of panning was strong and was third in the group, equal to Henry in loaf volume, but was exceeded slightly by Lathrop and Selkirk.

Minnesota - samples were received from the Crookston, Waseca, Morris, and Rosemount stations. Averages of the quality data for 11 varieties and strains from the four Minnesota stations are shown in table 1, in addition to the individual station results. A composite sample of flour by variety and strain was made from the four stations. This composite flour sample was used for the mixogram tests and also for baking tests by the remix method. The mixogram and remix baking results are shown in the table, along with the four station averages. The quality results will be discussed to a large extent on a consideration of the average data. The only exception to this is where some variety or strain has shown a particular quality property that should be specifically pointed out.

Most of the samples made reasonably good bread with little difference in quality among some of the varieties and strains. The protein content was generally highest for the Rosemount, Minnesota, samples, followed by the Waseca and Morris samples, with Crookston wheats lowest of the four stations. The low protein content of the Crookston samples was the principal reason for the low loaf volumes of the bread from this station. The Rosemount station made the best bread of the Minnesota stations. A number of these wheats made bread of exceptionally good grain. The ash contents of the flours for this year's Minnesota samples were somewhat higher than those tested last year. The Crookston samples had the longest dough mixing times of the four stations, with Morris intermediate, and Waseca and Rosemount shortest in mixing time of the station samples. The flour yields from the Morris samples were remarkably high considering the medium low test weights of the wheats. All the samples milled satisfactorily with the Crookston samples best. Many of them had excellent milling properties.

The hard red spring varieties, Thatcher, Lee, Selkirk, Conley and Pembina varied somewhat in strength, but all made reasonably satisfactory bread. Thatcher, lowest of the varieties in protein content, produced doughs having mellow to strong handling properties, and produced bread with a low (yellow) crumb color score. Lee and Selkirk were very similar in quality. The only exception to this was the flour yield which was higher for Selkirk. This is of interest especially since Selkirk had a 1.9 pound lower test weight than Lee. Conley produced a relatively high yield of flour for the medium test weight of the wheat (56.9 pounds), made bread of good volume, crumb color, and grain, and showed strong dough mixing properties according to the mixogram tests. The loaf volume of Conley by the remix method showed an increase over our regular bread method, indicating a strong quality wheat. Pembina is one of the strongest varieties in dough properties tested in recent years according to the mixogram studies. It had a long development and mixing tolerance time.

Comparable tests of ND 81 x Lee (ND 137, C.I. 13349) show that it was very similar to Lee in quality. The ash content of the flour was .05 percent higher and the absorption was 2.0 percent higher than that of Lee. In comparison to Selkirk, ND 137 was slightly lower in flour yield (1.5 percent), higher in flour ash content (.04 percent), higher in absorption (4.0 percent), and slightly longer in dough mixing properties. It was equal to Selkirk for the other characteristics for which comparisons were made.

Conley x ND 40-2 (ND 102, C.I. 13462) was better in test weight (1.5 pounds), higher in protein content (0.8 percent in the wheat) and absorption (2.0 percent), but lower in bread crumb color (6 points) and grain (8 points) than Conley. It had slightly stronger dough-mixing properties (mixogram tests) than Conley. It is a stronger wheat than Selkirk considering the overall quality properties. ND 102 was higher in test weight (1.4 pounds), protein content (wheat 1.3 percent and flour 0.9 percent), and absorption (4.0 percent), but lower in flour yield (0.6 percent) than Selkirk. The flour ash content averaged 0.53 percent and was .05 percent lower than the flour from Selkirk. It milled satisfactorily. The bread characteristics (loaf volume, crumb color, and grain) were similar, but the dough handling characteristics were stronger than those of Selkirk. The dough-mixing properties according to the mixogram tests were stronger than those of Selkirk. It is interesting that ND 102 has a development (mixing) time of 3.50 minutes and a longer mixing tolerance (4.75 minutes). This is a desired combination and one which is in demand in a wheat intended for bread. In most of the new wheats the mixing tolerance has been the shortest of the two quality measurements. A short mixing time and a long mixing tolerance are two of the desired properties wanted in a bread wheat.

Two selections from the cross II-44-29 x Lee[3] were tested for quality. One of the significant properties of the two selections was their very strong dough-mixing characteristics as shown by the long development time and mixing tolerance. Both of the selections II-53-562 (C.I. 13458) and -567 (C.I. 13416) were very similar in quality and did not differ greatly from Selkirk. The only exceptions are the higher test weights and absorptions, lower flour ash contents, and stronger dough properties (mixogram tests) of the strains as compared to those of Selkirk. Both selections showed strong bread-baking properties according to the remix method, as measured by the increased loaf volumes compared to our regular baking procedure.

KT-Tc^3 x II-44-29-Tc^2 (sel. No. II-53-404, C.I. 13465) is a strong wheat and is equal to or better than the comparably-grown Selkirk in a number of characteristics. It exceeded Selkirk in test weight (1.3 pounds), absorption (1.0 percent), and bread crumb color (6 points) and was lower in flour ash content (.04 percent). The milling characteristics were satisfactory with a few of the station samples excellent in this respect. It had stronger dough properties according to the mixogram tests than Selkirk or Lee. It showed medium strength by the remix method and produced better bread in loaf volume, color, and grain than by our regularly used bread baking method.

Comparable tests of Ftn-Tc^3 x II-44-29-Tc^2 (sel. II-53-525, C.I. 13466) show that, with the exception of a few properties, it was similar to Selkirk in quality. One of the exceptions to this was the yield of flour from sel. 525 which averaged 76.8 percent for a test weight of 59.4 pounds. Selkirk with a 2.4 pounds lower test weight produced about the same amount of flour as that of sel. 404. It averaged better than Selkirk in protein content (0.9 in the wheat), absorption (3.0 percent), and bread crumb color (10 points). The flour ash content was lower for sel. 525 than that of the comparably-grown Selkirk, Thatcher, or Lee. The dough-mixing properties according to the mixogram tests were similar to Lee and Selkirk and not so strong as those of Thatcher or Conley. It was not so strong as some of the other strains from the Minnesota trials according to the remix method. The remix loaf volume was a little higher, but the bread crumb color and grain were somewhat poorer than by our regular method of baking.

Uniform Regional Nursery Composite

Twenty-four wheats from the uniform regional nursery were tested in duplicate for their milling, baking, and chemical properties. These consisted of an eastern composite of grain by variety or strain from eight stations and a similar western composite of grain from six stations as shown in a footnote to the tables. The results of the quality tests for the eastern and western composites and the averages for both are shown in table 2.

Mixogram patterns or curves were made on the flours composited by variety or strain from the combined 24 eastern and western samples. The results of these tests show that there were differences in the dough characteristics between a number of the samples.

The remix straight dough method was used in testing the flours from the composited samples. The results of this bread-baking method are shown in the table of averages in comparison with the quality results obtained by our regular bread-baking method.

When possible, samples with similar quality characteristics have been grouped for purposes of discussion. Otherwise, individual evaluations of the strains have been made. The discussion of these nursery samples will be based principally on the averages.

Table 2. -- Milling, baking, and chemical results on 24 wheats grown in the Uniform Regional Nursery for the Eastern Composite, Western Composite, and the average of the Eastern and Western Composites in 1960

Variety or Cross	C.I. No.	Test Weight[1]	Pearling index	Protein[2]		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking data				Expected loaf volume
				Wheat	Flour	Yield[3]	Ash[2]				Bromate	Loaf volume	Crumb Color	Crumb Grain	
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c
Eastern Composite*															
Marquis	3641	55.7	27	13.6	13.0	75.7	.57	64	2.50	60	2	865	80	95	833
Thatcher	10003	58.4	27	14.0	13.1	76.3	.56	64	2.25	61	2	870	75	90	837
Selkirk	13100	57.8	32	14.2	13.7	78.1	.56	65	2.50	62	1	898	90	100	860
Lee	12488	59.4	31	14.8	13.8	75.8	.57	66	2.50	56	1	890	90	95	863
Conley	13157	58.6	30	14.6	13.7	77.2	.54	67	3.00	66	2	875	85	95	860
Pembina	13332	58.9	30	14.5	13.7	78.0	.54	66	3.75	70	2	910	85	90	860
Lathrop	13457	60.0	34	13.4	12.2	78.4	.51	64	2.50	60	2	885	70	95	802
Lee[2] x Ken Farmer	13463	59.4	28	13.9	12.8	77.2	.54	64	2.50	53	1	815	75	95	825
Tc[2] x Frontana-Thatcher	13464	59.6	29	15.5	14.3	74.0	.53	66	1.75	59	1	930	80	100	882
II-44-29 x Lee[3]	13458	59.8	32	14.3	13.3	78.5	.54	66	2.75	63	2	843	75	100	844
II-44-29 x Lee[3]	13416	59.3	32	14.3	13.2	77.7	.53	66	3.00	66	1	883	75	100	840
Klein Titan-Tc[3] x II-44-29-Tc[2]	13465	59.8	29	14.0	13.2	77.9	.53	66	3.00	50	2	835	85	85	840
Ftn-Tc[3] x II-44-29-Tc[2]	13466	60.4	30	14.8	14.9	77.1	.51	65	2.50	66	1	883	85	90	905
Conley x ND 40-2	13462	59.3	33	15.9	14.7	76.3	.54	65	3.00	72	2	880	80	95	898
ND81 x Lee	13349	59.1	31	14.6	12.9	76.6	.63	67	3.00	58	1	870	90	100	829
Lee x ND34	13461	59.1	32	14.9	13.9	76.6	.61	67	2.75	59	1	905	75	95	867
ND81 x Conley	13452	59.4	28	14.3	13.4	77.1	.61	68	3.00	45	1	858	75	95	848
(LeexND81 sib.)xLee	13453	60.1	30	14.3	13.8	77.9	.58	66	2.50	63	2	880	75	90	863
ND81 sib. x ND1	13603	60.1	31	14.6	13.5	77.2	.54	64	2.75	53	1	835	75	90	852
Conley x ND81	13604	58.8	30	14.3	13.4	76.6	.53	65	2.50	59	1	823	85	95	848
ND81 sib x Conley	13605	59.2	29	15.0	14.0	77.2	.57	68	2.25	52	1	905	80	90	871
ND81 sib x Conley[2]	13606	60.1	36	14.9	13.7	79.4	.52	61	2.50	67	2	855	80	95	860
N.2350 x [(Rmr-KF) x Ns 3880]	13607	60.6	29	15.1	14.4	76.3	.52	65	2.50	60	2	870	80	100	886
ND81 sib x Conley	13608	60.0	29	14.9	14.0	77.0	.55	66	3.00	63	1	895	80	95	871

*Composite of seed from Casselton, St. Paul, Crookston, Morris, Langdon, Fargo, Lincoln and Madison stations.

Table 2. -- Continued

Variety or Cross	C.I. No.	Test Weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]	Flour Ash[4]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.
						Western Composite*									
Marquis	3641	59.2	29	16.3	15.1	73.1	.56	65	1.75	64	1	998	80	95	913
Thatcher	10003	57.4	30	16.6	15.8	75.8	.54	65	1.75	67	2	975	75	100	940
Selkirk	13100	56.0	32	16.0	15.3	77.4	.53	65	1.75	66	2	985	75	95	921
Lee	12488	57.6	32	16.8	15.7	75.1	.56	68	1.75	62	2	925	80	95	936
Conley	13157	56.4	31	16.9	15.9	74.5	.53	66	1.75	67	2	975	75	95	944
Pembina	13332	56.1	31	16.6	15.8	76.7	.57	65	2.50	72	2	975	75	95	940
Lathrop	13457	58.8	34	15.5	14.5	77.9	.52	66	2.00	73	2	915	70	90	890
Lee^2 x Ken Farmer	13463	58.8	30	16.2	15.3	75.1	.55	69	2.25	69	1	970	70	95	921
Tc^{2}xFrontan-Thatcher	13464	56.9	29	17.5	16.9	73.7	.59	66	1.75	59	1	930	70	100	982
II-44-29 x Lee^3	13458	58.3	32	16.7	15.7	75.2	.53	68	2.25	66	1	945	85	100	936
II-44-29 x Lee^3	13416	58.0	31	16.7	15.4	75.9	.50	67	2.00	72	1	900	65	95	924
Klein Titan-Tc^3 x II-44-29-Tc^2	13465	57.6	30	16.2	15.4	75.0	.53	68	2.25	68	1	925	90	95	924
Ftn-Tc^{3}xII-44-29-Tc^2	13466	58.1	30	16.7	16.0	76.3	.52	67	2.25	73	2	965	85	85	947
Conley x ND40-2	13462	57.6	33	17.5	16.5	75.2	.51	69	2.25	70	1	960	80	95	967
ND81 x Lee	13349	57.1	31	16.9	15.8	74.8	.59	67	2.25	70	2	930	80	100	940
Lee x ND34	13461	59.1	30	17.2	15.8	71.6	.64	67	2.25	58	2	850	85	90	940
ND 81 x Conley	13452	57.5	28	16.4	15.2	73.5	.59	70	2.50	56	1	925	80	100	917
(Lee x ND81 sib)xLee	13453	57.3	30	16.7	15.6	74.4	.54	67	2.25	65	2	865	75	85	932
ND81 sib x ND1	13603	58.5	30	16.4	15.5	74.9	.54	67	2.50	68	2	930	85	95	928
Conley x ND 81	13604	56.3	28	16.7	15.5	71.6	.57	66	2.00	63	2	863	75	95	928
ND 81 sib x Conley$_2$	13605	56.1	28	17.6	16.7	73.6	.62	66	2.25	64	2	828	70	95	974
ND 81 xib x Conley^2	13606	58.0	34	16.9	15.8	76.7	.54	65	2.00	72	2	935	75	100	940
N2350x [(Rmr-KF) x NS 3880]	13607	58.8	28	17.1	16.3	74.2	.53	65	2.25	66	1	898	80	100	959
ND81 sib x Conley	13608	57.5	29	17.0	15.9	72.3	.61	67	2.25	66	1	870	75	90	944

*Composite of seed from Sidney, Sheridan, Laramine, Minot, Dickinson, and Fort Collins stations

Table 2. -- Continued

Variety or Cross	C.I. No.	Test Weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[2]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Quality of dough according to mixogram tests: Development time	Mixing tolerance	Remix baking data: Loaf vol	Crumb Color	Crumb Grain
		lbs.	Pct.	Pct.	Pct.	Pct	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.	C.c.	Score	Score
Averages of the Eastern and Western Composites																				
Marquis	3641	57.5	28	15.0	14.0	74.4	.56	64	2.13	62	1.5	931	80	95	873	2.25	1.50	885	75	85
Thatcher	10003	57.9	29	15.3	14.5	76.0	.55	64	2.00	64	2.0	922	75	95	889	2.50	1.75	955	70	80
Selkirk	13100	56.9	32	15.1	14.9	77.8	.55	65	2.13	64	1.5	942	83	97	910	2.75	1.50	940	75	85
Lee	12488	58.5	32	15.8	14.8	75.5	.56	67	2.13	59	1.5	908	85	95	899	2.00	1.50	898	75	90
Conley	13157	57.5	30	15.8	14.8	75.9	.54	66	2.37	66	2.0	925	80	95	902	2.75	1.75	950	85	85
Pembina	13332	57.5	30	15.1	14.7	77.3	.56	66	3.12	71	2.0	942	80	92	900	3.75	2.75	990	80	80
Lathrop	13457	59.4	34	14.4	13.4	78.1	.52	65	2.25	66	2.0	900	70	92	846	2.50	1.75	875	65	85
Lee[2] x Ken Farmer	13463	59.1	29	15.1	14.0	76.1	.54	66	2.37	61	1.0	893	72	95	873	3.25	1.50	945	70	90
Tc[2]xFrontana-Thatcher	13464	58.3	29	16.5	15.6	73.9	.56	66	1.75	59	1.0	930	75	100	932	1.75	1.50	800	85	75
II-44-29 x Lee[3]	13458	59.1	32	15.5	14.5	76.8	.54	67	2.50	64	1.5	894	80	100	890	2.75	2.00	895	80	85
II-44-29 x Lee[3]	13416	58.6	32	15.5	14.3	76.8	.52	66	2.50	69	1.0	891	70	97	882	2.00	2.50	940	75	80
Klein Titan-Tc[3] x II-44-29-Tc[2]	13465	58.7	30	15.1	14.3	76.4	.53	67	2.63	59	1.5	880	87	90	882	3.00	1.75	960	90	85
Ftn-Tc[3]xII-44-29-Tc[2]	13466	59.3	30	15.8	15.5	76.7	.52	66	2.37	70	1.5	924	85	87	926	2.75	2.00	958	85	80
Conley x ND 40-2	13462	58.4	33	16.7	15.6	75.8	.53	67	2.63	71	1.5	920	80	95	932	2.50	3.00	985	85	80
ND 81 x Lee	13349	58.1	31	15.8	14.4	75.7	.61	67	2.63	64	1.5	900	85	100	885	2.75	1.50	855	75	75
Lee x ND 34	13461	59.1	31	16.1	14.9	74.1	.63	67	2.50	58	1.5	878	80	92	903	2.25	1.00	925	80	90
ND81 x Conley	13452	58.5	28	15.4	14.3	75.3	.60	69	2.75	51	1.0	892	77	97	882	2.75	1.75	940	75	80
(LeexND81 sib) x Lee	13453	58.7	30	15.5	14.7	76.2	.56	66	2.37	64	2.0	892	75	87	897	2.75	1.25	930	80	90
ND81 sib. x ND1	13603	59.3	30	15.5	14.5	76.1	.54	66	2.62	61	1.5	883	80	92	890	2.75	1.75	950	85	85
Conley x ND 81	13604	57.5	29	15.5	14.4	74.1	.55	66	2.25	61	1.5	843	80	95	888	2.50	1.75	890	90	80
ND81 sib x Conley	13605	57.7	28	16.3	15.4	75.4	.59	67	2.25	58	1.5	866	75	92	923	2.00	1.75	813	70	75
ND81 sib x Conley[2]	13606	59.0	35	15.9	14.7	78.1	.53	63	2.25	69	2.0	895	77	97	900	2.50	1.50	868	80	95
N.2350x [(Rmr-K.F) x NS.3880]	13607	59.7	28	16.1	15.4	75.2	.52	65	2.37	63	1.5	884	80	100	922	2.25	1.25	930	85	95
ND81 sib x Conley	13608	58.7	29	15.9	15.0	74.7	.58	66	2.63	65	1.0	882	77	92	907	2.75	1.75	940	80	85

1/ Dockage free
2/ 14.0 percent moisture basis
3/ Moisture free

Most of the samples made reasonably good bread with little differences in quality. Perhaps the greatest difference between the two area composites was in their protein contents; the western samples were highest. There are also some other differences such as test weight, flour yield, ash content, and absorption between the two composites.

The western composite samples were relatively high in protein content with a number of them testing over 17.0 percent in wheat protein content. A few of the eastern composite samples tested higher than 15.0 percent in wheat protein content. The varieties and strains from both areas produced bread of exceptional grain with a great many of the samples scoring 95 and 100. The crumb color scores of the bread from the eastern composites were slightly better than those from the western composite samples. According to the mixogram tests two of the promising properties of a number of the strains were their strong dough characteristics (development time and mixing tolerance). Many of the strains also had desirable dough properties at the time of panning, an important property of a flour intended for bread. When considering the test weight of the wheats, one of the outstanding properties of these samples was the exceptionally good yields of flour (as high as 78.5 percent) obtained. The absorption was high (67.0 percent and above), a favorable property of a number of the strains. The flour ash contents of some of the strains were somewhat higher than the approved varieties included as standards of comparison. These high flour ash contents may or may not be an inherited characteristic. High ash is an objectionable property that should be avoided in a flour intended for bread purposes. The milling characteristics of a number of the strains were excellent with a great number of the others rated very good.

The approved hard red spring varieties, Marquis, Thatcher, Selkirk, Lee, Conley, and Pembina made generally satisfactory bread. Pembina was perhaps the strongest of these. It milled excellent, producing a high yield (77.3 percent) of flour and had strong dough-mixing properties according to the mixogram tests. This variety has been one of the strongest in the mixogram tests (development time and mixing tolerance) in recent years. The loaf volume of Pembina was increased some by the remix method in comparison to our regular Beltsville method, indicative of strength. Conley and Thatcher were next best in quality, followed closely by Lee and Selkirk. Some of the specific properties of these varieties were: Conley and Thatcher, excellent milling and strong dough properties and good loaf volumes by both baking methods; Lee, high absorption and very good grain of bread; Selkirk, high flour yield for the test weight of the grain, excellent milling characteristics, and mellow dough properties at the time of panning; and Marquis made good bread being somewhat higher in loaf volume than expected for the protein content of the flour, showing a slight decrease in loaf volume according to the remix method, indicating slightly weaker baking strength.

Lathrop (Henry[7] x P.I. 94587, Wis. 253) had excellent milling properties and produced a high yield of flour averaging 78.1 percent. This strain was the highest in flour yield of the comparably-grown wheats. The pearling index value indicated that Lathrop is a slightly softer wheat than Thatcher but about the same in hardness as Selkirk. The absorption was medium and was the same as Selkirk. The loaf volume of the bread was

slightly lower than expected for the flour protein content, and the internal bread properties were similar to those of Thatcher. The dough properties (development time and mixing tolerance) were the same as those of Thatcher. Baking tests by the remix method indicated satisfactory baking strength.

Lee^2 x Kenya Farmer (R.L. 2938) was similar to Lee in quality with possibly a few exceptions. R.L. 2938 was lower in protein content and bread crumb color score but had a longer development time according to the mixogram tests than Lee. It required a slightly lower amount of potassium bromate (an oxidation agent) for optimum bread than Lee. It milled satisfactorily having excellent characteristics especially for the eastern composite sample. Baking tests by the remix method indicated satisfactory strength.

Comparable quality tests of Tc^2 x Frontana-Thatcher (R.L. 4009) show that it was similar to Lee in many characteristics. R.L. 4009 was higher in wheat protein (0.7 percent), and lower in yield of flour (1.6 percent) and bread crumb color (10 points) than Lee. It milled satisfactorily. The doughs of this strain at the time of panning were mellow and like Lee in this respect. The quality of the doughs according to the mixogram tests tended to be weak. Baking tests by the remix method indicated poor baking strength as shown by the relatively larger decrease (130 cc.) in loaf volume compared to that of the regular baking procedure.

Two selections from a cross II-44-29 x Lee^3 were tested for quality. These selections, Nos. II-53-562 and 567, were similar to Lee except for a few quality properties. Both selections milled satisfactorily and produced 1.3 percent more flour than Lee. Sel. II-53-567 had excellent milling properties and was the lower in flour ash content of the two. In the mixogram tests both were somewhat stronger, considering the overall picture, than Lee.

The remix baking method indicated that sel. II-53-567 was perhaps the stronger of the two in bread strength. One favorable characteristic of these two selections was their satisfactory bread grain.

Klein Titan - Tc^3 x II-44-29-Tc^2 (II-53-404) was very similar to the comparably grown Conley in quality with possibly a few exceptions. Sel. II-53-404 was lower in wheat protein content (0.7 percent), slightly higher in crumb color of bread, and required about 25 percent less oxidation for optimum bread than Conley. It milled satisfactorily, producing a good yield of flour of reasonably low ash content. Baking tests by the remix method indicated a reasonably strong baking strength as shown by the increased loaf volume over that obtained by the regular baking method.

Tests of Ftn-Tc^3 x II-44-29-Tc^2 (II-53-525) show that it differed in quality from Selkirk in a number of respects. It exceeded Selkirk in wheat protein content (0.7 percent) and was lower in flour yield (1.1 percent), flour ash (.03 percent), and grain of bread (10 points). It had excellent milling properties and the dough characteristics at the time of panning were strong. Baking tests by the remix method indicated a medium baking strength.

Conley x ND 40-2 (ND 102) was very similar to Conley in quality. It was higher in wheat protein content (0.9 percent) than the comparably grown samples of Conley. It milled satisfactorily, producing a good yield of flour of reasonably low ash content. ND 102 had a longer mixing tolerance according to the mixograph tests than Conley. The remix method indicated a medium strong baking strength.

ND 81 x Lee (ND 137) was very similar to Lee in most characteristics. The only exceptions were the ash content of the flour which was higher (.05 percent) and the longer dough development time (in the mixogram tests) than that of Lee. The high flour ash content of ND 137 is apparently an inherited characteristic since tests of past years agree with the present results. The milling properties of ND 137 judged as good for both the eastern and western composites were poorer than those of either Lee or Selkirk. The baking tests by the remix method indicate that ND 137 was not quite as strong in baking strength as Selkirk or Lee. One of the most promising properties of ND 137 was the excellent grain in the bread from both eastern and western composites.

Lee x ND 34 (ND 138-1) was very similar to Lee. The exceptions to this were the higher flour ash content (.07 percent) and lower yield of flour (1.4 percent) than that of Lee. ND 138-1 required the same amount of oxidation for optimum bread as Lee. The dough handling properties of ND 138-1 at the time of panning were strong, elastic, and pliable. The milling properties of this strain were only fair for the western composite sample but satisfactory for the eastern composite. The mixing tolerance according to the mixogram test was short and not so strong as that of the approved varieties. The remix baking method indicated that ND 138-1 had medium-strong baking strength.

ND 81 x Conley (ND 153) was similar to Conley for many of the characteristics compared. The only exceptions were the higher flour ash content (.06 percent), lower amount of oxidation (potassium bromate) for optimum results, and higher absorption (3.0 percent). The milling properties of ND 153 were satisfactory and the baking strength acceptable by the remix method. The dough-mixing characteristics (development time and mixing tolerance) were medium strong.

(Lee x ND 81 sib.) x Lee (ND 162) was very similar to Selkirk in quality. The only exceptions to this were the higher test weight (1.8 pounds) and lower bread crumb color (8 points) and grain (10 points). ND 162 milled satisfactorily but produced less flour than Selkirk especially when considering the higher test weight of ND 162. Baking tests by the remix method indicated a medium strong baking strength.

ND 81 sib. x ND 1 (ND 208) was very similar to Selkirk in quality. ND 208 had excellent milling properties and was higher in test weight (2.4 pounds) but produced a lower yield of flour (1.7 percent) than Selkirk. The yield of flour from ND 208 was less than expected considering the test weight. The dough handling characteristics at the time of panning were strong. The remix baking method indicated satisfactory baking strength.

Conley x ND 81 (ND 218) was much like Selkirk in quality. The only exceptions to this were the lower flour yield (3.7 percent) and lower loaf volume by the regular baking method. The eastern composite sample had excellent milling properties. The quality of the doughs according to the mixogram tests were moderately strong and similar to the comparably grown samples of Conley and Thatcher. ND 218 showed satisfactory baking strength by the remix method.

The two ND 81 sib. x Conley selections (Nos. ND 220 and 256) were similar to Conley in most of their quality properties. ND 220 was higher in wheat protein (0.5 percent) and ash content of flour (.05 percent). It milled satisfactorily. The remix method indicates only medium baking strength. ND 256 was higher in test weight (1.2 pounds), and flour ash content (.04 percent) and required only half the amount of an oxidation agent for optimum bread as that of Conley. Baking tests by the remix method indicated ND 256 had medium strong baking strength.

ND 81 sib. x Conley^2 (ND 223) was similar to Conley. This strain was higher in test weight (1.5 pounds) and higher in yield of flour (2.2 percent) The pearling index value indicated that ND 223 was a slightly softer wheat than Conley. This selection had excellent milling properties. The remix method indicated medium baking strength. One favorable characteristic of this wheat was the very satisfactory grain in the bread when baked by our regular method.

N.2350 x [(Rmr-KF) x NS.3880] (ND 235) was similar to Lee in quality. The only exceptions to this were the higher test weight (1.2 pounds), lower flour ash content (.04 percent), and lower absorption (2.0 percent). ND 235 milled satisfactorily. It produced bread of excellent grain by our regular baking method. The development time was medium but the mixing tolerance short according to the mixogram tests. Baking tests by the remix method indicated medium strong baking strength.

State Nursery Trials

Results for the samples grown in the State nursery trials are shown in table 3. These include: samples from the station nursery at Madison, Wisconsin; composites of a number of varieties and strains grown in the advanced yield nursery at Huntley, Moccasin, Sidney, and Havre; Yield Nursery at Moccasin, Havre, and Sidney; Sawfly Yield Nursery at Sidney and Dutton; and Single-Row Yield Nursery at Moccasin, Havre, and Sidney, Montana.

Table 3. — Milling, baking, and chemical results on hard red spring wheats grown in State nursery trials, 1960 crop.

Variety or Cross	C.I. Nursery or Sel. No.	Test weight[1]	Pearling index	Protein[2]		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking data				Expected loaf volume	Quality of dough according to mixogram tests		Remix baking data		
				Wheat	Flour	Yield[3]	Ash[2]				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance	Loaf vol	Crumb Color	Crumb Grain
		lbs.	Pct.	Pct	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.	C.c.	Score	Score
Madison, Wisconsin																				
Lee	12488	59.5	29	14.3	13.2	74.7	.57	64	2.50	40	1	770	80	85	840	3.25	2.75	763	85	85
Lathrop	13457	60.2	36	13.5	12.5	78.6	.55	61	2.00	48	2	815	75	85	814	2.50	1.75	788	85	85
C.I. 12633 x Henry[2]	1-3-4	60.0	34	14.1	12.9	78.1	.56	61	2.00	42	2	873	85	95	829	2.50	1.50	735	75	80
Kenya 184 P2A1F	P.I.177167	61.1	34	13.2	11.8	76.1	.48	62	2.50	50	2	768	80	90	787	3.75	2.75	810	95	85
Wis. 250	13098	59.8	33	13.5	12.4	78.1	.53	61	2.00	37	2	798	85	85	810	2.25	1.25	655	60	60
Kenya 184xWis.250[4]	5-5-4-1	59.2	33	14.3	13.1	76.9	.56	61	2.50	48	2	798	90	85	837	3.75	3.25	853	85	85
ditto	6-2-1	60.2	32	14.5	13.7	74.9	.57	61	2.50	48	1	830	80	90	860	3.00	2.00	870	75	85
ditto	6-10-2-4	60.3	31	15.2	14.1	76.9	.51	61	2.75	55	1	815	80	85	875	3.75	3.50	945	85	90
ditto	6-12	60.6	30	14.4	13.5	76.3	.58	62	2.75	44	1	830	80	90	852	3.25	2.50	915	85	95
ditto	6-16-2	60.6	30	14.7	13.6	75.4	.57	64	3.00	45	2	875	80	95	856	3.00	2.75	895	85	90
Y-TK x Wis. 250[3]	1-2-5	59.6	33	13.0	12.0	77.7	.49	63	1.75	38	2	838	85	100	794	2.00	1.50	740	80	70
Y-TK x Wis. 250[3]	4-2-2-2	59.5	31	13.0	11.8	77.1	.50	64	2.75	33	1	830	85	95	787	2.50	1.75	710	80	70
Henry	12265	60.3	36	13.4	12.2	79.2	.53	63	2.50	43	1	850	85	100	802	2.75	2.25	805	75	75
Y-TK x Wis. 250[4]	17-1-3	60.3	31	13.1	11.9	78.7	.53	63	2.00	39	1	770	70	80	791	3.50	3.25	840	85	70
No.58xWis.250[2]	4-3-1-3-2	59.2	33	12.9	11.7	78.7	.52	61	2.50	32	1	780	85	90	783	2.75	2.25	723	80	65
No.58 x Wis.250[3]	1-1-1	60.6	32	13.6	12.2	77.8	.52	62	2.00	36	1	833	85	95	802	2.75	1.75	785	85	75
H515b-7-2-12-5		59.4	33	13.4	12.2	77.9	.50	62	2.50	42	1	795	80	85	802	3.50	2.00	863	90	85

Table 3. -- Continued

Variety or Cross	C.I., Nursery or Sel. No.	Test weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Quality of dough according to mixogram tests: Development time	Mixing tolerance
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.
								Montana Advanced Yield Nursery*									
Lee	12488	55.0	32	18.0	16.7	74.1	.56	63	2.00	66	2	888	85	90	974	2.00	1.25
Thatcher x Lee	B55-5	53.6	33	18.4	17.6	73.0	.51	62	2.00	73	2	995	80	90	1008	3.00	1.50
II-44-29 x Lee[3]	13458	55.5	32	17.5	16.4	74.3	.51	63	2.25	72	2	918	80	95	963	2.75	2.00
Thatcher[2] x Rescue	B57-191	51.8	24	18.5	17.9	69.3	.59	64	3.00	71	2	1018	70	85	1020	3.75	2.75
Selkirk	13100	51.7	30	17.3	16.8	74.0	.54	64	2.00	73	2	1040	85	100	978	2.50	1.50
Pembina	13332	53.2	28	17.9	17.2	72.9	.56	64	2.50	75	2	967	75	90	993	3.75	2.25
Thatcher	10003	53.0	26	18.6	17.8	72.1	.55	63	2.25	71	1	1005	85	90	1016	2.25	1.50
Rescue-N1315 x G.B.	B57-92	54.3	28	17.1	16.3	73.2	.49	62	2.25	74	1	983	80	100	959	4.25	1.75
Conley	13157	53.6	30	18.2	17.4	72.0	.50	62	2.25	72	2	945	80	90	1001	2.75	1.50
Centana	12974	53.8	24	18.5	17.7	69.2	.53	60	2.00	71	2	1075	85	85	1012	3.00	1.50
Rescue	12435	54.6	28	17.6	17.3	72.2	.54	60	2.50	73	1	1010	80	90	997	3.50	1.75
Thatcher[3] x Rescue	B57-196	52.8	23	18.3	17.2	69.2	.56	60	2.50	68	1	935	75	95	993	2.75	1.25
Lake	13413	51.4	26	19.4	18.5	71.7	.55	61	2.00	72	2	983	75	95	1035	2.50	1.25
Rescue-N1315xG.B.	B57-173	53.2	29	17.4	16.7	71.7	.50	60	3.00	74	1	1000	70	90	974	4.50	2.50
Minn.Sel. II-53-404	13465	55.6	28	17.8	16.8	73.3	.53	63	2.75	69	2	960	85	95	978	3.00	2.25
Chinook	13220	57.3	27	17.6	17.0	73.1	.52	63	2.25	67	2	935	80	100	985	2.75	1.50
Canthatch	13345	53.6	25	18.6	17.5	69.9	.56	62	2.50	71	2	955	70	90	1005	2.75	1.75
Sawtana	13304	56.4	26	17.6	17.0	74.4	.55	61	2.25	71	2	985	70	95	985	3.00	1.50
Minn. Sel. II-53-525	13466	54.6	27	17.9	17.5	73.1	.50	63	2.50	72	2	1025	70	90	1005	3.00	2.00
Ceres	6900	56.5	23	17.6	16.9	72.2	.56	66	2.50	72	1	988	80	90	982	2.50	2.00
II-44-29 x Lee[3]	13416	54.0	29	17.6	16.6	74.0	.52	64	2.50	73	2	1013	75	100	970	3.25	2.00
1953 x Lee (B52-91)	13242	54.6	28	17.1	16.2	73.4	.55	63	2.00	73	2	978	80	90	955	3.00	1.75

* Composite seed from Huntley, Moccasin, Sidney, and Havre stations.

Table 3. -- Continued

Variety or Cross	C.I., Nursery or Sel. No.	Test weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]/Ash[2]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Quality of dough according to mixogram tests: Development time	Mixing tolerance
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.
Montana Yield Nursery*																	
Rescue-N1315xG.B.	B57-174	55.4	31	17.1	16.1	73.2	.52	62	2.75	72	2	970	75	90	951	2.75	1.50
1953xLee, B52-91	13242	56.1	31	16.3	15.7	74.0	.51	63	2.25	72	1	960	90	100	928	2.75	1.50
Rescue-N1315xG.B.	B57-103	55.7	28	16.9	15.9	72.1	.54	63	2.75	71	2	990	70	85	944	3.00	2.00
Centana	12974	55.5	25	17.9	16.9	70.6	.58	60	2.25	70	1	980	75	85	982	2.50	1.00
Thatcher[4] x Rescue	B57-213	56.1	26	17.8	16.7	72.9	.60	62	2.25	69	2	910	75	90	974	2.50	.75
Norin 10 - Brevor 14 x Centana	B59-16	56.9	24	16.5	15.4	71.6	.52	62	2.00	69	2	950	95	100	924	1.75	.75
Rescue-N1315xG.B.	B57-1	55.0	28	17.3	16.5	72.0	.59	65	2.75	72	2	1015	80	90	967	2.50	1.50
Rescue-N1315xG.B.	B57-100	56.7	27	16.9	15.8	72.9	.55	62	2.50	71	1	970	75	90	940	3.00	1.50
Thatcher	10003	55.5	27	18.0	17.3	72.9	.52	63	2.25	68	1	1025	75	95	997	2.50	1.25
Thatcher[4]xRescue	B57-211	54.5	26	18.0	16.9	72.3	.54	63	2.25	68	2	965	70	95	982	2.75	1.50
Norin 10-Brevor 14 x Centana	B59-9	55.5	30	16.3	15.3	71.3	.43	62	2.25	70	1	915	80	90	921	2.00	1.50
Rescue-N1315xG.B.	B57-157	57.6	28	16.5	15.4	74.1	.48	62	3.00	72	1	970	75	90	924	3.00	2.00
Norin 10-Brevor 14 x Centana	B59-3	54.5	31	16.7	15.7	74.2	.43	63	2.25	73	1	985	85	100	936	3.00	1.50
Norin 10-Brevor 14 x Thatcher	B59-20	55.0	29	16.4	15.2	72.7	.41	63	2.00	72	2	920	70	90	917	3.00	1.25
Thatcher[2]xRescue	B57-194	55.5	28	17.7	16.7	71.7	.46	64	2.25	72	1	1033	80	100	974	2.25	1.50
Rescue-N1315xG.B.	B57-149	58.1	30	16.7	15.6	73.3	.47	63	2.75	75	1	1058	80	100	932	3.25	1.00
Rescue	12435	56.8	30	17.4	16.7	73.4	.53	64	2.50	73	2	1050	75	95	974	3.25	1.25
Rescue-N1315 x G.B.	B57-127	58.1	28	16.7	15.8	71.5	.50	63	2.50	74	1	1030	70	85	940	2.75	1.25
Norin 10 x Brevor 14 x Centana	B59-8	59.1	27	16.2	15.0	73.9	.44	68	2.25	71	2	958	80	90	909	3.00	1.25
Norin 10 x Brevor 14 x Centana	B59-11	56.1	28	17.2	15.9	72.0	.48	68	2.25	71	1	995	75	85	944	1.75	1.25
Norin 10 x Brevor 14 x Centana	B59-10	56.3	28	16.5	15.6	72.2	.49	67	2.50	73	1	1025	80	95	932	2.50	1.25
Thatcher[4]xRescue	B57-214	55.6	29	16.5	15.6	72.3	.45	67	2.00	72	1	1085	75	100	932	2.25	1.00
Norin 10 - Brevor 14 x Centana	B59-1	56.1	26	17.9	16.8	71.3	.54	71	2.25	69	1	1055	65	85	978	2.25	1.50
Norin 10-Brevor 14 x Centana	B59-17	57.0	26	16.7	15.6	73.2	.43	69	2.00	69	1	1100	80	90	932	1.75	1.00

* Composite seed from Moccasin, Havre, and Sidney stations

Table 3. -- Continued

Variety or Cross	C.I. No.	Test weight[1]	Pearling index	Protein[2]		Flour		Absorption	Mixing time	Optimum baking data				Expected loaf volume	Quality of dough according to mixogram tests	
				Wheat	Flour	Yield[3]	Ash[2]			Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.
Montana Sawfly Yield Nursery*																
Thatcher-K.F.xRescue	13420	60.8	38	15.3	14.5	76.3	.45	64	2.25	2	898	100	95	890	2.25	1.25
Chinook	13220	59.3	31	14.6	13.9	74.7	.46	62	2.50	2	900	90	90	867	3.00	1.50
Thatcher[4] x Rescue	13412	61.0	34	14.1	13.6	77.6	.46	61	2.25	2	895	90	95	856	2.50	1.25
Sawtana	13304	59.9	38	15.1	14.8	76.8	.45	62	2.50	1	938	95	95	901	3.75	2.00
II-50-17 x 51-2688	13475	60.0	32	14.6	14.0	77.4	.50	65	3.00	2	955	100	90	871	3.25	1.75
Thatcher	10003	59.3	34	15.4	14.4	75.1	.50	62	2.25	1	905	85	100	886	2.50	1.50
Rescue	12435	59.2	37	14.3	14.0	75.8	.51	59	2.50	2	890	95	90	871	3.25	1.50
Rescue-N1315xG.B.	13410	59.5	33	14.4	13.5	75.7	.49	64	2.75	1	958	80	90	852	2.75	1.50
Rescue-N1315xG.B.	13409	58.2	36	15.2	14.5	75.5	.48	66	2.75	1	958	95	95	890	2.75	1.75
C.T. 601 x H46145	13472	58.7	40	14.8	14.2	74.6	.47	65	2.50	1	893	90	90	878	2.50	1.75
Rescue x Chinook	13344	61.7	36	15.0	14.4	76.1	.46	66	2.50	1	898	100	95	886	3.00	1.75
II-50-17 x 15-2688	13474	58.6	33	15.4	14.9	75.3	.45	68	3.00	1	950	85	100	905	3.50	2.00
51-1802 x N.D. 4	13473	61.0	37	15.1	14.8	77.0	.47	66	2.75	1	900	95	100	901	3.75	2.75
Rescue x Cadet	13328	59.6	30	15.0	14.3	75.3	.48	66	3.00	2	925	90	100	882	4.00	2.75

*Composite seed from Sidney and Dutton stations

Table 3. -- Continued

Variety or Cross	C.I., Nursery, or Sel. No.	Test weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]	Flour Ash[2]	Absorption	Mixing time	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Rank	Quality of dough according to mixogram tests: Development time	Mixing tolerance
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Mg.	C.c.	Score	Score	C.c.		Min.	Min.
Single Row Yield Nursery[4]																	
N2211 x Centana	B60-1	56.5	30	17.9	16.8	73.6	.52	64	2.25	2	988	75	95	978	1	3.00	2.00
N2211 x Centana	B60-2	53.6	36	18.6	17.8	72.5	.51	62	2.75	2	925	80	95	1016	1	2.25	1.75
N2211 x Centana	B60-3	54.0	30	18.9	17.4	71.7	.53	62	2.00	2	960	70	85	1001	1	2.00	1.75
N2211 x Centana	B60-4	54.4	33	18.3	17.0	73.2	.52	63	2.25	2	999	70	90	985	1	1.50	1.75
Thatcher	10003	54.0	30	18.9	17.8	71.8	.52	62	2.00	2	1055	75	90	1016	1	2.25	1.50
N2211 x Centana	B60-5	53.4	34	18.6	17.3	73.4	.51	64	2.50	2	1073	70	95	997	1	2.50	2.25
N2211 x Centana	B60-6	53.5	33	18.6	17.3	72.9	.54	63	2.25	2	1005	70	90	997	1	2.25	1.75
Reward x N2211	B60-10	54.8	28	19.1	18.2	72.4	.52	66	2.50	2	1040	70	85	1032	1	2.75	2.00
Reward x N2211	B60-11	56.1	28	20.0	19.2	70.8	.53	64	2.25	2	1015	80	95	1061	2	2.25	1.75
Centana[5]	12974	56.4	28	18.4	17.5	72.1	.52	63	2.00	2	1018	85	95	1005	2	2.25	1.25
Reward x N2211	B60-15	56.0	28	18.3	17.5	72.3	.60	66	2.00	2	895	75	95	1005	2	2.25	1.75
Reward x N2211	B60-16	56.5	28	18.5	16.7	72.0	.59	66	2.00	2	905	70	95	974	2	2.00	1.50
Reward x N2211	B60-17	57.0	29	18.5	17.6	72.8	.53	63	2.00	2	1005	70	85	1008	1	3.00	2.00
Norin 10 x Centana	B60-19	55.8	31	16.8	16.0	71.2	.58	63	2.00	2	975	75	90	947	2	2.00	1.25
Norin 10 x Centana	B60-20	53.6	30	17.7	16.8	72.7	.52	60	2.50	2	875	85	90	978	3	1.50	1.00
Norin 10 x Centana	B60-21	54.4	35	16.4	15.0	71.6	.49	63	2.00	2	945	85	90	909	1	2.75	1.75
Thatcher	10003	54.1	29	18.6	17.6	74.8	.56	64	2.00	2	960	90	85	1008	1	1.50	1.50
Thatcher[4] x Lee	B60-26	54.0	29	19.2	18.4	73.2	.56	64	2.00	2	1010	90	85	1036	1	2.00	1.00
Thatcher[5] x Lee	B60-28	55.6	32	18.6	17.8	75.0	.53	64	1.75	2	960	90	85	1016	1	2.00	1.00
Thatcher[5] x Lee	B60-29	55.0	31	18.7	17.8	73.7	.54	65	2.00	2	1015	85	85	1016	1	2.00	1.50
Centana	12974	55.4	27	18.7	17.8	72.7	.54	62	2.25	2	1050	90	85	1016	1	2.00	1.25
Rescue-N1315 x G.B.	B60-35	56.5	29	17.8	16.3	72.8	.52	63	2.50	2	980	85	80	959	1	3.25	1.75
Rescue-N1315 x G.B.	B60-37	56.5	30	17.0	16.3	72.9	.52	64	2.50	2	1000	90	95	959	1	2.50	2.00
Rescue-N1315xG.B.[5]	B60-39	57.0	31	17.6	16.6	72.4	.51	65	2.25	2	1018	90	85	970	1	2.25	1.50
Rescue-N1315xG.B.[5]	B60-40	51.0	35	18.9	18.5	76.2	.60	65	2.50	2	980	80	80	1042	1	2.75	3.00
Centana[5]	12974	56.0	27	18.3	17.5	72.0	.55	67	2.00	2	1100	95	95	1005	1	2.50	1.50
P.I. 56219-7xRescue	B60-41	57.0	27	17.8	17.3	74.3	.59	66	2.50	2	1045	85	80	997	1	3.00	2.50
P.I.56206-11xRescue	B60-43	55.5	30	17.9	17.1	74.5	.55	64	2.50	2	935	85	90	989	1	2.25	1.75
Thatcher[2] x Rescue	B60-46	55.7	26	18.5	17.5	70.9	.53	65	2.00	2	965	80	85	1005	2	2.00	1.50
Thatcher[2] x Rescue	B60-47	53.4	30	18.2	17.4	75.1	.50	65	2.00	2	973	85	85	1001	2	2.00	1.50
Thatcher	10003	53.0	29	18.7	18.0	72.9	.55	66	2.25	2	1015	85	90	1023	1	2.25	1.50

Table 3. — Continued

Variety or Cross	C.I. Nursery, or Sel. No.	Test weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]	Flour Ash[2]	Absorption	Mixing time	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Rank	Quality of dough according to mixogram tests: Development time	Mixing tolerance
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Mg.	C.c.	Score	Score	C.c.		Min.	Min.
Thatcher[4] x Rescue	B60-50	54.4	29	17.8	17.3	72.8	.54	59	2.50	2	850	90	90	997	3	2.00	2.00
Thatcher[4] x Rescue	B60-51	54.4	28	17.9	17.2	72.1	.58	70	2.50	2	900	75	90	993	1	2.25	1.75
B49-102 x K.338	B60-53	59.0	29	17.2	16.0	73.8	.50	67	2.25	2	945	85	90	947	1	2.25	1.25
B49-102 x K.338	B60-54	58.0	30	17.6	16.8	75.6	.48	67	2.25	2	910	75	95	978	1	2.00	1.25
B49-102 x K.338	B60-55	57.0	31	16.9	15.8	75.4	.47	67	2.00	2	978	80	95	940	1	2.25	1.25
B49-102 x K.338	B60-57	58.4	29	17.6	16.4	74.0	.57	67	2.00	2	853	70	100	963	2	2.00	1.25
B49-102 x K.338	B60-58	56.5	32	17.9	17.0	73.3	.56	69	2.50	2	938	70	95	985	1	2.25	1.50
Thatcher	10003	53.4	30	18.6	17.9	73.0	.58	69	2.25	2	1005	70	95	1020	1	2.25	1.50
Centana x B49-90	B60-59	56.6	24	18.4	17.8	71.8	.64	74	2.75	2	1035	80	95	1016	3	2.50	1.50
Centana x B49-90	B60-60	55.8	26	18.7	18.1	72.3	.62	72	2.25	2	995	75	95	1027	3	2.25	1.25
Centana x B49-102	B60-61	55.6	27	18.1	17.3	74.3	.56	70	2.00	2	965	75	95	997	2	2.25	1.00
Ditto	B60-63	57.4	28	18.4	17.7	71.6	.58	66	2.50	2	908	75	95	1012	1	3.00	2.25
Ditto	B60-65	57.7	24	17.4	16.6	71.7	.53	67	2.50	2	945	75	95	970	1	2.50	2.00
Ditto	B60-66	55.4	25	18.0	16.9	72.0	.54	68	2.75	2	945	65	90	981	2	3.50	1.75
Ditto	B60-67	56.0	26	17.9	17.0	71.9	.50	67	2.75	2	978	85	90	985	1	2.25	1.50
Centana	12974	55.6	28	18.1	17.2	73.8	.51	66	2.75	2	995	90	100	993	1	2.50	1.50
Centana x B49-102	B60-68	55.4	28	18.0	16.6	72.4	.49	67	2.50	2	935	85	100	970	1	2.75	1.75
Ditto	B60-70	57.0	27	17.9	17.0	68.8	.53	68	2.50	2	935	85	95	985	2	2.50	1.50
Ditto	B60-71	57.8	26	18.0	16.9	69.9	.53	68	2.50	2	988	85	100	981	2	2.00	2.00
Thatcher	10003	53.5	30	18.9	18.2	72.4	.55	66	2.00	2	1025	75	95	1032	2	2.25	1.25
Centana x B49-102	B60-77	53.7	32	18.8	18.1	72.4	.53	66	2.00	2	990	80	85	1027	1	2.25	1.50
Centana x B49-102	B60-78	55.6	28	17.8	17.0	72.5	.55	66	2.25	2	1000	80	90	985	2	2.00	1.00
(C.T.918 x H46 146)x (C.T .186 x6060)	B60-80	56.0	31	18.9	17.7	74.5	.57	68	3.25	2	950	70	80	1012	1	2.75	2.75
II-50-17 x Pilot	B60-82	54.8	28	17.9	17.4	73.7	.49	69	2.75	2	1040	85	90	1001	1	2.50	2.00
N2211 x Centana	B60-85	55.6	28	18.0	17.3	71.8	.49	68	2.50	2	970	75	85	997	1	2.75	2.00
Centana	12974	54.8	28	18.6	17.6	69.8	.48	67	2.25	2	1100	85	90	1008	1	2.50	1.25
N2211 x Centana	B60-86	54.8	29	17.9	17.2	71.9	.42	68	2.25	2	1075	85	85	993	1	2.50	2.00
Reward x Thatcher	B60-87	56.1	29	18.2	17.3	72.1	.52	66	2.25	2	1050	90	95	997	1	2.75	1.25
Thatcher[3] x Rescue	B60-88	56.3	27	18.9	17.7	72.2	.51	69	2.25	2	960	80	85	1012	3	2.00	1.50
Thatcher[3] x Rescue	B60-89	54.0	31	18.6	17.3	71.0	.51	67	2.00	2	965	70	100	997	3	2.25	1.50
S-615 x N2389	B60-90	56.4	31	18.7	18.2	74.0	.46	68	2.50	2	1110	80	90	1032	3	2.25	1.75
S-615 x N2389	B60-91	57.1	31	18.0	17.6	74.0	.49	67	2.00	2	1075	85	90	1008	2	2.00	1.25
B49-102 x N2389	B60-92	57.8	28	18.1	17.1	73.2	.54	67	2.50	2	973	85	95	989	1	3.00	2.00
Ditto	B60-93	57.6	29	18.0	16.8	75.1	.53	68	2.25	2	1050	80	95	978	2	2.00	1.75
Ditto	B60-94	58.1	31	17.9	17.0	73.4	.50	66	2.00	2	985	80	90	985	2	2.00	1.25
Thatcher	10003	54.2	30	18.5	17.5	72.7	.55	67	2.25	2	1000	80	90	1005	2	2.00	1.50

Table 3. -- Continued

Variety or Cross	C.I., Nursery, or Sel. No.	Test weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]/Ash[2]	Flour Ash[2]	Absorption	Mixing time	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Rank	Quality of dough according to mixogram tests: Development time	Mixing tolerance
		lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Mg.	C.c.	Score	Score	C.c.		Min.	Min.
B49-102 x N2389	B60-96	58.0	31	17.5	16.7	72.8	.53	66	2.25	2	948	85	100	974	2	2.50	1.50
Ditto	B60-97	57.4	30	17.9	16.9	72.6	.54	62	2.00	2	930	75	95	981	2	2.00	1.00
Ditto	B60-98	58.1	28	17.9	17.1	73.3	.57	64	2.25	2	1010	80	95	989	1	2.75	1.75
Rescue x N2389	B60-99	57.5	31	17.8	17.9	74.8	.52	64	2.25	2	1033	85	90	1020	1	2.75	1.50
Rescue x N2389	B60-100	59.1	29	17.9	16.8	72.9	.57	65	2.25	2	943	70	85	978	2	2.25	1.50
B50-18 x Rescue	B60-102	57.4	32	17.9	17.0	73.7	.54	65	2.25	2	995	75	95	985	1	2.50	1.50
B50-18 x Rescue	B60-103	57.5	32	17.6	16.8	74.6	.53	64	2.25	2	1025	70	95	978	1	2.25	1.75
Centana	12974	54.4	28	19.0	17.6	71.6	.55	63	2.25	2	1088	80	90	1008	1	2.00	1.75
Thatcher[5] x Rescue	B60-106	54.8	31	17.7	17.0	74.3	.54	64	2.25	2	980	75	85	985	1	2.50	1.50
Ditto	B60-107	56.0	29	18.5	17.3	72.9	.58	68	2.00	2	973	80	100	997	2	2.00	1.50
Ditto	B60-109	55.4	27	18.9	17.5	72.6	.57	68	2.50	2	1010	75	95	1005	2	2.25	1.75
Ditto	B60-112	54.4	30	18.4	17.2	71.2	.53	67	2.00	2	968	80	95	993	2	1.50	1.00
Thatcher	10003	54.8	30	18.2	16.8	72.4	.55	64	2.00	2	980	75	90	978	1	2.00	1.25
Thatcher[5] x Rescue	B60-113	56.0	27	17.5	16.7	72.8	.59	66	2.75	2	918	70	85	974	1	2.25	2.25
II-50-25 x Rescue	B60-114	54.0	42	18.6	17.4	70.2	.52	64	2.00	2	1073	75	90	1001	1	2.00	1.25
K.F. x Rescue	B60-115	55.8	42	18.6	17.1	70.0	.58	64	2.00	2	1043	70	90	989	2	2.00	.75
Ditto	B60-117	57.2	38	18.1	16.7	72.0	.49	64	2.00	2	1018	70	90	974	2	2.00	1.00
Ditto	B60-118	56.6	39	18.4	16.8	71.4	.48	63	2.00	2	1035	70	85	978	2	2.00	1.25
Ditto	B60-119	56.6	36	18.5	16.7	71.2	.48	63	2.25	2	998	70	90	974	1	3.00	2.00
Ditto	B60-120	55.0	32	18.4	16.9	75.9	.47	64	2.25	2	1002	65	85	981	2	2.50	1.00
Centana	12974	55.7	28	18.2	17.2	73.7	.52	63	2.25	2	1108	75	90	993	1	2.25	1.00
K.F. x Rescue	B60-123	55.6	38	18.3	16.8	70.7	.50	63	2.00	2	1050	65	90	978	2	1.75	1.00
Thatcher[4] x Lee	B60-125	55.2	34	18.2	17.4	74.8	.49	65	2.25	2	1045	60	85	1001	1	2.25	1.25
Irradiated Rescue	B60-127	54.6	25	17.4	16.4	75.2	.54	67	2.75	2	950	80	100	963	1	3.00	2.00

1/ Dockage free
2/ 14.0 percent moisture basis
3/ Moisture free
4/ Composite seed from Sidney, Moccasin, and Havre stations
5/ No seed from Havre stations

Station Nursery

Madison, Wisconsin

Mixogram and the remix bread-baking tests were made on the samples, in addition to the chemical, milling, and the regular bread-baking tests. When possible, samples with similar quality characteristics have been grouped for purposes of discussion. Otherwise, individual evaluations of the strains have been made.

The familiar varieties, Lee and Henry made generally satisfactory bread. Henry was perhaps the strongest of the two in quality considering the data as a whole. It was higher in flour yield and lower in flour ash content and produced better bread by our regular method than Lee. The quality of the dough according to the mixogram tests was not quite so strong as that of Lee. Both varieties are considered only average in strength when baked by the remix method. Both varieties had satisfactory milling properties with Henry excellent in this respect. One of the outstanding bread properties of Henry was the excellent grain produced by regular baking tests. Lee produced a lower loaf volume and Henry a higher loaf volume than expected for the protein content of their flours.

Lathrop (Wis. 253, C.I. 13457) had excellent milling properties and produced a high yield of flour of 78.6 percent. The pearling index indicated that it is a slightly softer wheat than Lee, but the same in hardness as Henry. The absorption was medium and loaf volume about that expected for the flour protein content. The oxidation (potassium bromate) requirements for best bread results were twice as high as those of Lee and Henry. The dough properties at the time of panning were slightly weak, and according to the mixogram tests not so strong as those of either Lee or Henry. Baking tests by the remix method indicated medium baking strength. In fact, Lathrop is very much like Henry in quality with the exception of the few properties already mentioned.

C.I. 12633 x Henry^2 (sel. No. 1-3-4) was similar to Henry in quality with possibly a few exceptions. It was higher in wheat protein content (0.7 percent) and lower in yield of flour (1.1 percent) and absorption (2.0 percent). It had excellent milling properties. The dough properties at the time of panning were slightly weak and in the mixogram tests not quite so strong as Henry. Baking tests by the remix method indicated low baking strength as shown by the relatively larger decrease (138 cc.) in loaf volume as compared to that of the regular baking procedure. The satisfactory milling properties, high flour yield, and good bread grain were the outstanding characteristics of sel. No. 1-3-4.

Kenya 184 P.2.A.1.F (P.I. 177167) was much like Lee in quality for a number of the characteristics. The differences between the two for certain of the properties were large and for most relatively important. P.I. 177167 was much lower in wheat protein content (1.1 percent) and flour ash content (.09 percent). It differed to a smaller extent from Lee in that it was higher in test weight (1.6 pounds) and flour yield (1.4 percent) and lower in absorption (2.0 percent). It had excellent milling properties. The quality

of the dough according to the mixograph tests shows the development (mixing) time to be strong but the mixing tolerance medium. It is similar to Lee in these properties. The dough handling properties at the time of panning were slightly short. Baking tests by the remix method indicated satisfactory, but not outstanding, baking strength.

Wis. 250 (C.I. 13098) had excellent milling properties and produced a relatively high yield of flour considering the 59.8 pounds test weight of the wheat. It was similar to the comparably-grown Henry in wheat protein and ash content of flour. It made good bread by our regular method and was similar to Lee in this respect. C.I. 13098 was 3.0 percent lower than Lee in absorption. The mixogram test showed this cross to have a satisfactory development (mixing) time but a short mixing tolerance (1.25 min.) time. The doughs were weak and sticky at the time of panning, an unfavorable characteristic in a bread wheat flour. Baking tests by the remix method indicated poor baking strength as shown by a large decrease (143 cc.) in loaf volume in comparison with our regular baking procedure.

Five selections from the cross Kenya 184 x Wis. 250[4] were tested. One of the most significant and promising quality properties of these selections was their strong dough characteristics as shown by the mixogram tests. The development (mixing) time was relatively long and the mixing tolerance medium to long for most of the samples. All of the selections milled satisfactorily with yields of flour equal to or better than expected when considering the test weight of the wheats. The wheat protein contents of the selections were higher (0.9 to 1.8 percent) than the comparably-grown Henry. A number of the selections were about the same as Lee which was higher in wheat protein content than Henry. Selection No. 6-10-24 was strongest of the wheats in quality considering the data as a whole. It was highest in wheat protein content, excellent in milling properties, and lowest in flour ash content. It produced satisfactory bread by our regular method. The mixogram tests indicated strong dough properties. The handling properties of the doughs at the time of panning were also found to be strong. Baking tests by the remix method indicated strong baking strength as shown by the relatively large increase in loaf volume (130 cc.) as compared to that of our regular baking procedure. This selection has many promising quality characteristics that should make it a satisfactory bread wheat. Selection No. 5-5-4-1 was perhaps next best. Its milling properties were very good, yield of flour was slightly higher than expected for the test weight of the wheat, and quality of the dough was strong according to the mixogram tests. The flour ash content was slightly higher than that of Henry. The remix baking method indicated medium baking strength. Selections Nos. 6-2-1, 6-12, and 6-16-2 appear to be very similar in quality. All made good bread by our regular baking method. The mixograph tests show satisfactory quality. These three selections were highest in flour ash content, exceeding Henry in this respect. Sel. No. 6-16-2 was best of the wheats in absorption. The dough handling properties at the time of panning were strong. The remix method indicated medium baking strength with sel. No. 6-12 slightly stronger than the other two.

Two selections from the cross Y-TK x Wis. 250^3 (Nos. 1-2-5 and 4-2-2-2) appear, with a few exceptions, to be similar in quality to the comparably-grown Henry. Both selections had excellent milling properties and produced a high yield of reasonably low ash flour. Two of the favorable properties of these selections were their satisfactory grain in the bread and absorptions. The doughs of both were mellow and slightly sticky at the time of panning, not a favorable characteristic. The remix method indicated a weaker baking strength for these selections as shown by the decrease in loaf volume obtained in comparison with the regular procedure.

Y-TK x Wis. 250^4 (sel. No. 17-1-3) was similar in milling and chemical characteristics but differed to some extent in baking and mixogram properties from Henry. Sel. No. 17-1-3 had a slightly lower pearling index value, an indication of a harder kernel texture, and bread by the regular method was lower in loaf volume and internal characteristics than that made from Henry. In the mixogram tests it was stronger than Henry as indicated by the longer development and mixing tolerance times. The doughs from sel. No. 17-1-3 were mellow at the time of panning and not quite so strong as Lee or Henry in this respect. Baking tests by the remix method indicated medium satisfactory baking strength. Sel. No. 17-1-3 showed an increase in loaf volume by the remix method; whereas Henry showed a decrease as compared to the loaf volume obtained by the regular baking method.

Comparable quality tests of No. 58 x Wis. 250^2 (sel. No. 4-3-1-3-2) show that it was similar to Henry for most of the characteristics compared. The only exceptions to this were the lower test weight (1.1 pounds), absorption (2.0 percent), and grain of bread (10 points). This selection had excellent milling properties. The dough handling properties at the time of panning were mellow. The remix baking method indicated only fair strength.

No. 58 x Wis. 250^3 (sel. No. 1-1-1) was very similar to Henry in most of the chemical, milling, and baking properties. Sel. No. 1-1-1 had excellent milling characteristics, but yielded 1.4 percent less flour than Henry. The dough was mellow at the time of panning and the remix baking method indicated only fair baking strength.

H515b-7-2-12-5 differed very little from Henry in quality. It was lower in yield of flour (1.3 percent), ash content of flour (.03 percent), and bread grain (15 points). The quality of the dough according to the mixogram tests shows this selection to have a longer development time but about the same mixing tolerance as that of Henry. The dough of this selection was strong at the time of panning and the remix baking method indicated medium baking strength.

Advanced Yield Nursery

Huntley, Moccasin, Sidney, and Havre, Montana

The varieties and strains for this Montana composite have been evaluated on the basis of the quality data as a whole. A number of the samples made exceptionally satisfactory bread.

All the wheats were extremely high in protein content, with none lower than 16.2 percent in the flour. Nine of the 22 samples were 18.0 percent and higher in wheat protein content. The variety Lake was highest of the samples tested in recent years, and had a wheat protein content of 19.4 percent (14.0 percent moisture basis). The optimum amount of water (absorption) required to bring the dough to the standard consistency in the breadmaking process was high for a number of the samples. This is one of the favorable properties of these strains and varieties. The dough-mixing times were longer for some of the strains than the approved hard red spring varieties included as standards of comparison. This is a favorable characteristic. The flour yields were reasonably high and better in some instances (74.0 percent and above) than expected when considered in relation to the generally low to medium test weights of the wheats. The crumb color of the bread as a group tended to score low being yellow rather than white, the latter a preferred characteristic. The yellow crumb color is perhaps not too objectionable since it is a common practice to bleach flour to the desired whiteness in the wheat-milling process. Crumb color, nevertheless, should be considered in evaluating the wheats for bread. The ash content was normal and about that expected when considering the flour yields.

The approved and named hard red spring wheat varieties made generally satisfactory bread. Selkirk was one of the better varieties in bread loaf volume and grain of crumb. It produced a higher-than-expected-loaf volume, considering the protein content of the flour. Pembina had strong dough-mixing properties, according to the mixogram tests; but the crum color of the bread was yellow and lower than that of Thatcher. Conley was of strong quality for bread although the loaf volume was slightly lower than expected for the protein content of the flour. Centana and Rescue were much alike in quality for bread. The only exception was the flour yield of Centana which was lower than that of Rescue. The loaf volume of Lake was slightly lower than expected according to the flour protein content, and the crumb color of the bread was yellow. Chinook produced bread exceptionally satisfactory in crumb grain. The yield of flour for this variety was not as high as expected, considering the test weight of the wheat. Canthatch is a strong wheat of good dough-mixing properties. The flour yield was low, but perhaps about that expected for the low test weight of the wheat. The crumb color of the bread was yellow and not so white as that of Thatcher. Sawtana and Ceres were much alike in quality and made satisfactory bread, except that the crumb color of the bread from Sawtana was yellow.

Thatcher had a slightly longer dough-mixing time, 1 percent higher flour protein content, and 10 points lower bread grain than Selkirk. The dough-handling properties of Thatcher at the time of panning were strong and elastic. Thatcher required only half as much potassium bromate (an oxidation agent) as Selkirk. The quality characteristics of strains will be compared with Thatcher. Thatcher x Lee (B55-5) was very similar to Thatcher in quality and made bread of satisfactory volume, grain, and crumb color. This is perhaps best of the strains in this nursery. The other strains differed in some quality characteristics from Thatcher. II-44-29 x Lee[3] (C.I. 13458) was higher in test weight but lower in protein content (1.1 percent in the wheat and 1.4 percent in the flour). Thatcher[2] x Rescue (B57-191) was lower in test weight (1.2 pounds), flour yield (2.8 percent),

and the crumb color of bread (15 points), but had stronger dough-mixing properties than Thatcher. Rescue-N1315 x G.B.(B57-92) was lower in protein content (1.5 percent in the wheat and flour), scored better in flour, ash, and bread crumb grain, and was stronger in dough-mixing characteristics according to the mixogram tests than Thatcher. The dough development time was extremely long for this strain. Thatcher[3] x Rescue (B57-196) was lower by 2.9 percent in flour yield, 3.0 percent in absorption, 70 c.c.s in loaf volume, and 10 points in bread crumb color. Rescue-N1315 x G.B.(B57-173) was lower in wheat (1.2 percent) and flour (1.1 percent) protein content and 15 points in crumb color of bread than Thatcher. B57-173 had strong dough-mixing properties, according to the mixogram tests and was one of the better strains in this respect. Minn. sel. II-53-404 (C.I. 13465) had a lower protein content (wheat 0.8 percent and flour 1.0 percent), a higher test weight (2.6 pounds), and stronger dough-mixing properties; Sel. II-53-525 (C.I. 13466) was lower in wheat protein content (0.7 percent), lower in flour ash (.05 percent), 15 points lower in bread crumb color, but stronger in dough-mixing properties than Thatcher. Both strains II-44-29 x Lee[3] (C.I. 13416) and 1953 x Lee (B52-91, C.I. 13242) were lower in protein content (approximately 1.0 percent in the wheat and 1.5 percent in the flour) than Thatcher. C.I. 13416 was down in crumb color (10 points) but better in bread crumb grain (10 points) than Thatcher. Both of these strains were slightly stronger in dough mixogram values than Thatcher.

Yield Nursery

Moccasin, Havre, and Sidney, Montana

All the varieties and strains for this Montana composite were relatively high in protein content with none lower than 15.0 percent in the flour. The optimum amount of water (absorption) required to bring the dough to the standard consistency in the bread-making process was high for a number of the samples, a favorable property. The dough-mixing times of the strains were generally similar to those of the approved hard red spring varieties included as standards of comparison. The flour yields were reasonably high and better in some instances (73.0 percent and above) than expected when considered in relation to the generally low-to-medium test weights of the wheats. The crumb color of the bread as a group tended to score low, being yellow rather than white; the latter is a preferred characteristic. The ash content was low (0.49 and less) for a number of the flours, a favorable property.

Thatcher, Centana, and Rescue included as standards of comparison, produced satisfactory bread. Centana tended to be higher in flour ash content than expected. Rescue produced a slightly higher loaf volume, a favorable property, than expected for the protein content of the flour. The dough handling properties of these three varieties were strong at the time of panning.

The quality characteristics of the strains will be compared with the properties of the parent variety Rescue, Thatcher, or Centana.

Thatcher^{2} x Rescue (B57-194) made satisfactory bread and differed only in a few respects from Thatcher and Rescue. It was 1.2 percent lower in flour yield, .06 percent lower in flour ash content, 1.0 percent higher in absorption, but otherwise was similar to Thatcher in overall quality. Unlike the parent material, the dough at the time of panning was mellow rather than strong. It was lower in test weight (1.3 pounds), flour yield (1.7 percent), and flour ash (.07 percent), but had a slightly shorter dough-development time according to the mixograph test than Rescue. Thatcher^{2} x Rescue required the minimum amount of oxidation agent for optimum bread. This is a promising strain qualitywise.

The three selections from Thatcher^{4} x Rescue appeared to be alike in quality except for a few properties.

Selection No. B57-211 had the strongest dough quality properties according to the mixogram tests of the three selections. It was similar for most of the characteristics for which comparisons have been made except for the test weight which was 1 pound lower than that of Thatcher and 2.3 pounds lower than Rescue.

Selection No. B57-213 had a high flour ash content, fair milling properties, and a very short dough-mixing tolerance. It was higher in flour ash content (.08 percent) and lower in absorption (1.0 percent) and produced bread having a loaf volume of 115 cc. less than that of Thatcher. Compared to Rescue, selection no. B57-213 was higher in flour ash content (.07 percent) and lower in loaf volume (140 cc.).

Selection No. B57-214 had a low flour ash content (.45 percent), high absorption (67.0 percent), and a higher loaf volume according to the flour protein content than expected. Selection no. B57-214 was lowest of the three crosses in protein content. It made good bread but was materially lower in protein content (1.5 percent in the wheat and 1.7 percent in the flour) than the comparably grown Thatcher. One of the favorable properties of this strain was its low flour ash content. Compared to Rescue, selection no. B57-214 was lower in protein content (wheat 0.9 percent and flour 1.1 percent) and lower in flour ash (.08 percent).

These three strains had shorter development times than Rescue according to the mixogram tests.

1953 x Lee (Selection B52-91, C.I. No. 13242) was one of the highest in yield of flour, produced bread having excellent grain, and scored high in crumb color. The protein content was lower than that of the three varieties included for comparative purposes. The dough-handling properties at the time of panning were sticky and mellow and not so strong as that of Thatcher or Centana.

There was some variation in quality among the seven Rescue-N1315 x Golden Ball crosses. All milled satisfactorily. In some cases the differences between the crosses and Rescue were only minor, but this should be considered when determining the value of these crosses in relation to the others for increase or discarding. These selections differed from Rescue in the following respects:

Selection No. B57-174 was 2.0 percent lower in absorption, 1.4 pounds in test weight, and 80 cc. in loaf volume.

Selection No. B57-1 was 1.8 pounds lower in test weight, .06 percent higher in flour ash content, and 1.4 percent lower in flour yield.

Selection No. -100 was lower in flour protein content (0.9 percent), absorption (2.0 percent), oxidation requirements (50 percent), and loaf volume (80 cc.)

Selection No. -103 was lower in flour protein content (.08 percent), test weight (1.1 pounds), bread grain (10 points), and flour yield (1.3 percent).

Selection No. -157 was lower in wheat and flour protein content (0.9 to 1.3 percent, respectively), absorption (2.0 percent), flour ash content (.05 percent), loaf volume (80 cc.), and oxidation requirements (50 percent). The lower ash content of selection no. -157 is a favorable property of this strain. Both of the selection nos. -149 and -127 were lower in wheat protein content (0.7 percent) and higher in test weight per bushel (1.3 pounds) than Rescue. In addition, selection no. -149 was lower in flour ash content (.06 percent) and absorption (1.0 percent), and selection no. -127 was lower in flour yield (1.9 percent) and oxidation requirements (50 percent).

The dough-handling properties of these strains as a group were strong, a few of the selections had mellow, while others had bucky characteristics. These strains as a whole made bread of very satisfactory grain.

The quality characteristics of the eight selections from Norin 10 - Brevor 14 x Centana will be discussed in comparison with the chemical and bread-baking properties of Centana. All of the strains milled satisfactorily and produced a higher percentage of flour than Centana. Strains B59-3, -8, and -17 were best in this respect. These varied from 2.6 to 3.6 percent higher in flour yield than Centana. Selection no. -3 had excellent milling properties.

As a group, the strains produced flour of lower ash content than the flour from Centana. Five of the selections were 0.10 to 0.15 percent lower in this respect than Centana.

One of the eight selections (No. -1) was equal to and the others varied from moderately to considerably lower (0.7 to 1.7 percent) in wheat protein content than Centana.

One important and better property than Centana was the higher absorption of the Norin 10 - Brevor 14 x Centana strains. These ranged from 2.0 percent more for selections nos. -9 and -16 to 11.0 percent more for selection No. -1.

The best selections, considering the data as a whole, were selection Nos. -1 and -17. Selection No.-1 was 10 points lower in crumb color and higher in loaf volume, but otherwise both selections were much like Centana in quality for bread. Both produced slightly larger loaf volumes than Centana. All three were about the same in flour protein content.

The other selections differed from Centana as follows:

Selection No. -16 was 1.4 pounds higher in test weight per bushel, 20 points in bread crumb color, and 15 points in grain.

Selection No. -3 was lower in test weight (1.0 pound) and better in bread crumb color (10 points) and grain (15 points) and had stronger dough properties.

Selection No. -8 was higher in test weight (3.6 pounds) and stronger in dough-mixing properties (mixograph tests).

Selection No. -10 made bread that was 10 points better in grain and slightly higher in loaf volume.

Selection No. -11 had a slightly shorter dough development (mixing) time than Centana according to the mixogram tests.

These six selections, as already mentioned, varied from medium to considerably lower in protein content than Centana. They were superior to Centana in absorption, flour yield, and ash content of flour which appears to be an inherent property of this cross. There is some indication that the lower protein content (in seven of the eight strains) may also be another inherent property of this cross.

Sawfly Yield Nursery

Sidney and Dutton, Montana

All the wheats were relatively high in protein content, with none lower than 14.1 percent in the wheat. The optimum amount of water (absorption) required to bring the dough to the standard consistency in the bread-making process was high for a number of the samples. This is one of the favorable properties of these strains and varieties. The dough-mixing times were longer for some of the strains than the approved hard red spring varieties included as standards of comparison. This is

a favorable characteristic. The flour yields were reasonably high and better in some instances (76.0 percent and above) than expected when considered in relation to the test weights of the wheats. The loaf volumes were about that expected for the protein content of the flour, and the crumb color and grain of the bread were satisfactory. The grain was especially good for a number of the samples scoring 100 for the loaves from a number of these strains. The ash content of the flour was medium to low and better than expected considering the high flour yields.

Chinook, Sawtana, Thatcher, and Rescue included as standards of comparison produced generally satisfactory bread. Chinook was low in flour ash content. Sawtana produced a high yield of flour, was low in flour ash content, and made bread that scored high in crumb color and grain. Thatcher made bread that was lowest in crumb color of the approved varieties, but the bread grain was excellent. Rescue produced about the yield of flour expected for the test weight of the wheat, but the ash content of the flour was high.

The quality characteristics of the strains will be compared principally with the properties of the variety Rescue except for a few comparisons that may seem advisable with the other varieties included in this nursery. Six of the strains appear to be good in quality, considering the data as a whole, and were equal to or better in some of their properties than those of Rescue. These strains and their better quality properties in comparison with those of Rescue are as follows:

Rescue - N1315 x G.B. (C.I. 13409) -- Higher protein content (wheat 0.9 percent and flour 0.5 percent), lower flour ash (.03 percent), and much higher absorption (7.0 percent).

Rescue x Chinook (C.I. 13344) -- Higher test weight (2.5 pounds), higher wheat protein content (0.7 percent), lower flour ash (.05 percent), much higher absorption (7.0 percent), and 5 points better bread crumb, color, and grain.

Rescue x Cadet (C.I. 13328) -- Higher wheat protein content (0.7 percent) and absorption (7.0 percent), better in dough-mixing characteristics than Rescue or Thatcher according to the mixogram tests, and stronger dough properties at the time of panning.

Strain II-50 - 17 x 51 - 2688 (C.I. 13474) -- Higher in protein content (wheat 1.1 percent and flour 0.9 percent), lower in flour ash (.06 percent), materially higher in absorption (9.0 percent), and 10 points higher in bread grain. The crumb color of this strain was 10 points lower than that of Rescue, but this is not especially important since the crumb color can be improved by bleaching.

Another promising strain in the nursery was 51 - 1802 x ND 4 (C.I. 13473) -- higher than the comparably-grown Rescue in test weight (1.8 pounds), protein content (wheat and flour 0.9 percent), flour yield (1.2 percent), absorption (7.0 percent), and 10 points in bread grain. It was also lower in flour ash content than Rescue.

Thatcher - K.F. x Rescue (C.I. 13420) -- Higher test weight (1.6 pounds), protein content (wheat 1.0 percent and flour 0.5 percent), absorption (5.0 percent), lower in flour ash content (.06 percent) than Rescue.

Most of these strains required 50 percent less oxidation for optimum bread than Rescue. The only exceptions were Rescue x Cadet and Thatcher - K. F. x Rescue which required half again as much and was the same as Rescue in this respect. The higher protein content and the remarkably higher absorption than those of Rescue are important properties of these wheats.

Those wheats that were next best and much like Rescue, except for a few properties, are as follows:

Thatcher[4] x Rescue (C.I. 13412) had a 1.8 percent higher flour yield, .05 percent lower flour ash, 2.0 percent higher absorption, and slightly shorter dough-mixing properties.

Rescue - N1315 x G.B. (C.I. 13410) was 5.0 percent higher in absorption and 15 points lower in bread crumb color and had a slightly shorter dough development (mixogram) time.

C.T. 601 x H 46145 (C.I. 13472) was lower in flour yield (1.2 percent), lower in ash content (.04 percent), and higher in absorption (6.0 percent).

II - 50 - 17 x 51 - 2688 (C.I. 13475) was 1.6 percent higher in flour yield, 6.0 percent higher absorption, and 5.0 percent lower in pearling index value.

These four strains do not seem to have as much to offer as the other six strains in the way of quality as a replacement for Rescue.

All the wheats in this nursery milled satisfactorily.

Single Row Yield Nursery

All the samples were very high in wheat protein content, with the greatest majority of them between 17.0 and 20.0 percent. There was considerable range in flour yield, ash content, and absorption. Most of the loaf volumes were about that expected considering the flour protein contents. A number of the wheats produced bread of good internal characteristics and the quality of the dough according to the mixogram tests was equal or superior to the standard varieties included for comparisons. Most all of the strains milled satisfactorily producing, in some cases, excellent yields of flour when considered in relation to their test weights.

Thatcher and Centana, included as standards of comparisons, performed satisfactorily and in the manner similar to their known qualities. Thatcher milled satisfactorily and showed considerable strength for bread, but the bread crumb color was slightly more yellow than that of most of the other approved varieties. The milling properties of Centana were satisfactory,

yield of flour about that expected for the test weight of the grain, flour ash content low, and crumb color of the bread good to excellent. The loaf volume and grain of the bread were satisfactory.

The varieties and strains have been ranked numerically into three groups. This ranking was based to a large extent on a consideration of all quality factors. Some quality factors are more important than others. The weight given these factors, eg., high flour ash, low flour yield, poor dough mixing properties, etc., are not desirable; whereas high loaf volume for the protein content of the sample, high absorption, good internal bread characteristics, etc., are some of the desirable characteristics considered important in ranking the strains. The small differences in quality between a number of the strains have made it extremely difficult to rank the wheats.

A discussion of the samples with comments or remarks about the quality of some of the strains which account for their ranking is as follows:

N2211 x Centana. Eight of the selections from this cross have been ranked first in quality for bread. Sel. no. B60-1 is perhaps strongest of these. Sel. no. B60-86 was lowest of the group in flour ash content. Sel. no. B60-4 had the shortest dough development time according to the mixogram curve.

Reward x N2211. Two of the selections ranked first in quality with sel. no. B60-17 perhaps best. Sel. no. B60-11 was low in flour yield and sel nos. B60-15 and 16 high in flour ash content, the reason for ranking them second.

Norin 10 x Centana. Sel. no. B60-21 was best of the wheats in quality. It was low in flour ash content and showed good strength in the mixogram curves. The flour ash content of sel. no. B60-19 was high (ranked second) and sel. no. B60-20 was ranked third because of low loaf volume for the protein content of the flour, and the quality of the dough according to the mixogram curve was weak.

Thatcher x Lee - backcrosses. All three selections were ranked first in quality with not much difference between them.

Rescue-N1315 x G.B. - The four selections from this cross were perhaps some of the best wheats from this nursery. Sel. no. B60-40 was the strongest of these wheats and had strong dough handling properties. The pearling index value indicated that this selection was semi-hard and the ash content not so low as the other selections. Sel. 60-40 also produced a high yield of flour, an important property of a satisfactory bread wheat.

Thatcher x Rescue - backcrosses. Three of these eleven backcrosses have been ranked first in strength. These were sel. nos. B60-51-106 and 113. The flour ash content of a number of these backcrosses were high varying from .57 to .59 percent. Sel. no. B60-50 ranked low because of low flour yield, and sel. nos. B60-88, 89, and 112 because of weak, sticky dough handling properties. It is of interest that a number of these selections had high absorptions, a favorable property.

P.I.56219-7 x Rescue (B60-41) was an excellent wheat and one of the strongest in quality in this nursery. The only questionable property of this strain was its slightly high flour ash content. Its dough properties were very strong.

P.I. 56206-11 x Rescue (B60-43) was a good quality wheat of average bread-baking properties.

B49-102 x K.338. Some of the important properties of these five strains were their high absorptions and flour yields and good milling properties. Sel. nos. B60-57 and 58 were high in flour ash content and sel nos. B60-54 and 55 excellent in milling properties. Sel. no. B60-57 also was low in loaf volume, one of the reasons for ranking this selection second in quality.

Centana x B49-90. Both strains were ranked third because of their high flour ash contents. Both have made good bread with exceptionally high absorptions. They only milled fair and were not so satisfactory as either Centana or Thatcher in this respect.

Centana x B49-102. A number of the selections for this strain made bread of excellent grain, produced good flour yields, and had strong dough mixing properties. The doughs as a group were strong and bucky at the time of panning. The best of these strains were sel. nos. B60-63, 65, 67, 68, and 77. A number of the wheats were ranked in second place because of the following reasons: Sel. nos. B60-61 and 78 poor mixing tolerance; Sel. no. B60-66 low crumb color; and B60-70 and 71 low flour yield.

(C.I. 918 x H46146) x (C.T. 186 x 6060) (B60-80). This was one of the stronger wheats in this nursery. It milled satisfactorily producing a high yield of flour, had strong dough mixing properties according to the mixogram tests, and was high in absorption. It was low in bread crumb color but similar to Thatcher in this respect. The flour ash content of this strain was slightly higher than that of Thatcher or Centana.

II-50-17 x Pilot (B60-82) appeared to be a good quality wheat. It was low in flour ash and had strong dough mixing qualities.

Reward x Thatcher (B60-87) produced bread of good quality and had strong mixing properties. It appeared similar to Thatcher except for bread crumb color in which it exceeded Thatcher.

S-615 x N2389 (B60-90 and 91). These two selections appear to be very similar except that the dough characteristics of sel. no. 90 were weak and sticky, an objectionable property of a wheat. This may not be very serious, especially since this selection has such a low flour ash content and high loaf volume.

B49-102 x N2389 (B60-92, 93, and 94). Sel. no. B60-92 appeared to be the best of these three selections in quality. It had a slightly stronger dough mixing property (mixogram curves), otherwise all three wheats were very similar quality wise.

B49-102 x N2389 (B60-96, 97, and 98). All three of these selections were very similar in quality. Sel. no. B60-98 was perhaps slightly the stronger of the three in dough mixing properties. All made bread of good grain.

Rescue x N2389 (B60-99 and 100). Sel. no. B60-99 appeared to be the best of these two because of its lower flour ash content, higher flour yield, and slightly longer mixing time according to the mixogram curves.

B50-18 x Rescue. Both of these selections, nos. B60-102 and 103, were strong wheats and not very different in quality. The flour yield of sel. 103 was the higher of the two.

II-50-25 x Rescue (B60-114) had a high pearling index value indicative of a soft textured wheat, and produced a low yield of flour in comparison with other wheats of similar test weight. One of its favorable properties was the high loaf volume it made in comparison with other strains in this nursery of comparable protein content.

K.F. x Rescue. The five selections from this cross (except for B60-120) had high pearling index values indicative of a softer textured wheat than either Thatcher or Centana. Most of them produced better loaf volumes than expected in comparison with the flour protein contents. The bread crumb color was low but similar to Thatcher in this respect. The best selection of the group appeared to be sel. no. B60-119 which was based to some extent on a consideration of its favorable dough qualities.

Irradiated Rescue (B60-127) appeared to be one of the stronger wheats in this nursery. It milled satisfactorily producing a good yield of flour, had strong dough properties, and made good bread.

Commerical Samples

As in past years, a number of commercially grown wheat samples were obtained through the Grain Division, Agricultural Marketing Service, for comparison with the varieties and strains produced in experimental plots. Twenty-five such samples representing a number of grades and subclasses were obtained at Great Falls, Montana, and Minneapolis and Duluth, Minnesota. The samples were composited by grade from 2154 cars of wheat grading No. 5 or better. This is the twenty-second season such samples have been tested. The results are given in table 4.

Table 4. -- Milling, baking, chemical and physical results on 28 composite commercial samples from 2154 cars of hard red spring wheat obtained at Duluth, Great Falls, and Minneapolis representing the 1960 crop.

Location Where Obtained	U.S. Grade	No. of cars	Test weight[1]	Pearling index	Protein[2]		Flour		Absorption	Mixing time	Sedimentation value	Optimum Baking Data				Expected loaf volume	Quality of dough according to mixogram tests		Remix baking data		
					Wheat	Flour	Yield[2]	Ash[2]				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance	Loaf volume	Crumb Color	Crumb Grain
			lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.	C.c.	Score	Score
Duluth, Minn.	1HDNS	30	60.2	30	12.8	12.2	77.1	.53	64	2.50	50	1	878	80	90	802	3.00	3.00	850	70	85
	1DNS	126	58.8	32	13.9	13.0	76.2	.52	64	2.75	61	1	958	100	100	833	3.00	3.25	930	80	90
	2DNS	177	58.1	33	14.5	13.6	77.2	.52	65	2.75	68	1	950	95	100	856	2.75	2.50	960	80	100
	4DNS	52	54.6	32	15.5	14.6	76.3	.58	65	2.50	68	1	988	80	100	894	3.00	2.00	980	75	80
	5DNS	20	52.4	31	15.5	14.7	74.3	.57	63	2.50	72	1	960	75	95	898	3.50	2.50	975	75	85
	1NS	34	57.6	32	12.2	11.5	77.3	.54	64	3.00	44	1	890	80	95	775	3.00	3.00	850	75	85
	2NS	43	57.6	33	12.7	12.0	77.4	.52	65	2.75	54	1	920	80	100	794	3.25	2.50	865	70	90
	3NS	29	56.7	33	12.8	12.1	77.5	.52	64	2.50	44	1	915	85	100	798	3.25	3.00	875	80	85
Great Falls, Mont.	1HDNS	123	61.4	32	14.3	13.4	78.1	.49	65	2.25	69	1	930	95	85	848	3.00	2.25	870	65	80
	1DNS	282	59.0	33	15.4	14.7	74.8	.50	63	2.50	72	2	975	75	90	898	2.25	3.00	983	85	85
	2DNS	154	57.6	31	15.9	15.3	73.8	.51	64	2.50	71	1	970	85	95	917	3.25	2.25	968	85	80
	2DNS	16	60.0	32	15.2	14.1	75.7	.49	66	2.50	73	1	990	80	100	875	2.25	2.00	945	75	80
	3DNS	122	57.3	30	16.2	15.2	75.0	.53	66	2.50	71	2	990	75	85	917	2.75	2.00	1000	75	90
	3DNS	168	56.4	30	17.0	15.8	74.4	.52	66	2.50	72	1	1010	80	90	940	2.75	2.00	1045	75	85
	4DNS	35	54.8	30	17.2	16.2	73.9	.54	64	2.50	73	2	1025	75	90	955	3.25	2.50	1000	75	75
Minneapolis, Minn.	1HDNS	77	60.8	34	13.8	13.2	75.4	.52	65	2.50	54	2	880	85	90	840	2.75	2.50	905	70	85
	1DNS	138	59.0	34	14.1	13.4	76.9	.52	64	2.50	51	1	873	85	85	848	3.00	2.50	935	80	90
	2DNS	128	57.8	32	14.6	14.0	76.0	.53	66	2.50	58	2	865	75	85	871	3.00	2.75	980	75	90
	3DNS	187	56.2	33	14.9	14.2	76.0	.57	65	3.00	60	2	958	85	95	878	2.75	3.00	953	80	95
	4DNS	58	54.5	32	14.9	14.4	75.4	.56	65	2.75	67	1	975	85	95	886	3.00	3.00	990	75	95
	5DNS	8	52.3	29	15.5	14.6	74.4	.58	66	3.00	70	1	963	100	95	894	3.75	2.50	1003	75	95
	1NS	38	58.7	34	12.8	12.5	78.4	.56	63	2.75	46	2	885	80	90	814	3.75	2.50	875	80	95
	2NS	56	57.8	34	13.4	12.5	77.4	.56	63	2.75	42	2	900	85	90	814	3.00	3.00	955	80	90
	3NS	44	56.7	35	13.7	12.7	78.2	.55	63	2.50	44	1	920	95	95	821	3.50	3.00	950	75	85
	4NS	9	53.9	38	13.8	13.1	77.9	.54	65	2.75	47	1	915	90	95	837	3.75	3.00	980	75	85

1/ Dockage free
2/ 14.0 percent moisture basis
3/ Moisture free

These wheats varied in protein content with a number of the samples much like the varieties and strains grown in experimental plot and nursery trials. The Minneapolis and Duluth, Minnesota, wheat samples averaged 14.2 percent and 13.7 percent, respectively; the Great Falls, Montana, samples were somewhat higher, averaging 15.9 percent. The milling characteristics were much alike for the commercial and experimental samples. The baking and chemical results do not appear to be greatly different when compared with samples having approximately the same protein contents.

Strains and Varieties of Current Interest

Each year many new wheats are tested along with the leading commercial varieties for chemical, milling, and bread-baking quality. The data on one recently named variety and four strains of current interest, with averages of comparable samples of a number of approved hard red spring varieties, are shown in table 5.

N.D. 81 x Lee (N.D. 137, C.I. 13349)

Six comparable tests of N.D. 81 x Lee (N.D.137, C.I. 13349) show that it is similar to Selkirk for nearly all of the quality properties for which it was tested.

The test weight of N.D. 81 x Lee was 0.9 pound and the flour yield 1.3 percent lower than that of Selkirk. The milling properties of N.D. 137 were satisfactory. The other exceptions were the ash content of the flour which was .05 percent higher and the absorption which was 3.0 percent higher than that of Selkirk. The doughs at the time of panning were mellow. The quality of the doughs (development time and mixing tolerance) according to the mixogram tests were similar to Selkirk. Bread baking tests by the remix method indicated satisfactory baking strength. The grain of the bread by the remix method was 10 points lower than the bread of Selkirk.

Conley x N.D. 40-2 (N.D. 102, C.I. 13462)

Comparable chemical, milling, physical, and baking tests of five samples of Conley x N.D. 40-2 (N.D. 102, C.I. 13462) showed that it differed from Selkirk in a number of properties. Conley x N.D. 40-2 was higher in test weight (1.1 pounds), protein content (wheat 2.7 percent and flour 1.4 percent), and absorption (3.0 percent) but lower in flour ash content (.04 percent) than Selkirk. The milling properties of N.D. 102 were satisfactory varying from very good to excellent for the five samples tested. The yield of flour was not so high as expected considering the bushel weight of the samples and averaged about the same as Selkirk. The dough development time was similar, but the mixing tolerance much longer (stronger) than that of Selkirk according to the mixogram tests. The doughs at the time of panning were mellow to strong. The baking test by the remix method indicated medium strong baking strength.

Table 5. -- Average quality characteristics of a number of strains and varieties of current interest compared with approved varieties of hard red spring wheat

Variety or Cross	years repre. in tests	No. of samples	C.I. No.	Test weight[1]	Pearling index	Protein[2] Wheat	Protein[2] Flour	Flour Yield[3]	Flour Ash[2]	Absorption	Mixing time	Sedimentation value	Optimum baking data: Bromate	Loaf volume	Crumb Color	Crumb Grain	Expected loaf volume	Quality of dough according to mixogram tests[4]: Development time	Mixing tolerance	Remix baking data[4]: Loaf vol.	Crumb Color	Crumb Grain
				lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	C.c.	Score	Score	C.c.	Min.	Min.	C.c.	Score	Score
ND 81 x Lee	1960	6	13349, ND137	58.0	31	14.6	13.5	75.6	.62	.67	2.96	49	1.7	872	79	93	851	2.88	1.88	875	78	80
Selkirk		6	13100	58.9	32	14.1	13.4	76.8	.57	.64	2.50	52	1.7	885	82	94	849	2.75	1.75	907	80	90
Conley x ND 40-2	1960	5	13462, ND102	58.4	32	15.6	14.5	76.1	.53	.67	2.95	61	1.4	906	79	90	891	3.00	3.88	984	83	90
Selkirk		5	13100	57.3	31	13.9	13.1	76.8	.57	.64	2.45	50	1.6	873	82	94	840	2.75	1.75	908	80	90
II-53-404[5]	1960	7	13465	58.0	29	14.4	13.6	75.9	.53	.65	2.89	50	1.6	857	85	91	856	3.33	2.25	925	88	90
Selkirk		7	13100	56.6	32	14.6	13.8	76.4	.56	.64	2.43	55	1.7	905	83	95	868	2.75	1.75	908	80	90
1953 x Lee (B-52-91)	1954	9	13242	58.7	33	15.3	14.2	73.1	.42	.63	2.06	69	1.6	889	88	92	878	2.88	1.62	--	--	--
Lee	to	9	12488	58.7	34	16.5	15.4	72.2	.48	.64	2.11	64	1.6	803	87	91	924	2.13	1.25	--	--	--
Selkirk	1960	9	13100	56.7	33	15.7	14.9	73.9	.46	.64	2.14	70	2.0	928	86	93	905	3.00	1.50	--	--	--
Lathrop	1959 &	3	13457	59.2	34	13.5	12.4	77.7	.56	.61	2.08	48	1.7	804	78	85	810	2.75	1.50	788	85	85
Henry	1960	3	12265	58.3	33	13.4	12.2	78.1	.56	.63	2.42	43	1.7	814	78	90	802	2.88	1.75	805	75	75
Lathrop	1959 &	6	13457	59.2	34	14.3	13.4	77.7	.53	.64	2.17	61	1.8	861	76	89	848	2.73	1.66	875	65	85
Selkirk	1960	6	13100	56.5	31	15.1	14.5	76.4	.56	.67	2.25	62	1.7	888	82	96	890	2.83	3.00	940	75	85

1/ Dockage free
2/ 14.0 percent moisture basis
3/ Moisture free
4/ Determinations made on 1 to 3 samples
5/ Klein Titan-Thatcher^3 x II-44-29-Tc^2, C.I. No. 13465

II - 53 - 404 (C.I. 13465)

Seven comparable tests of selection II-53-404 from the cross Klien Titan-Thatcher[3] x II-44-29-Tc[2], (C.I. 13465) showed that it was similar to Selkirk for many of the characteristics for which comparisons have been made. The only exceptions were the higher test weight (1.4 pounds), slightly lower flour ash content (.03 percent), and the slightly stronger dough mixing properties according to the mixogram tests as compared with that of the comparably-grown Selkirk. The milling properties of sel. II-53-404 were satisfactory, varying from very good to excellent. The crumb color and the grain of the bread from sel. II-53-404 were similar to that from Selkirk. Baking tests by the remix method indicated satisfactory baking strength.

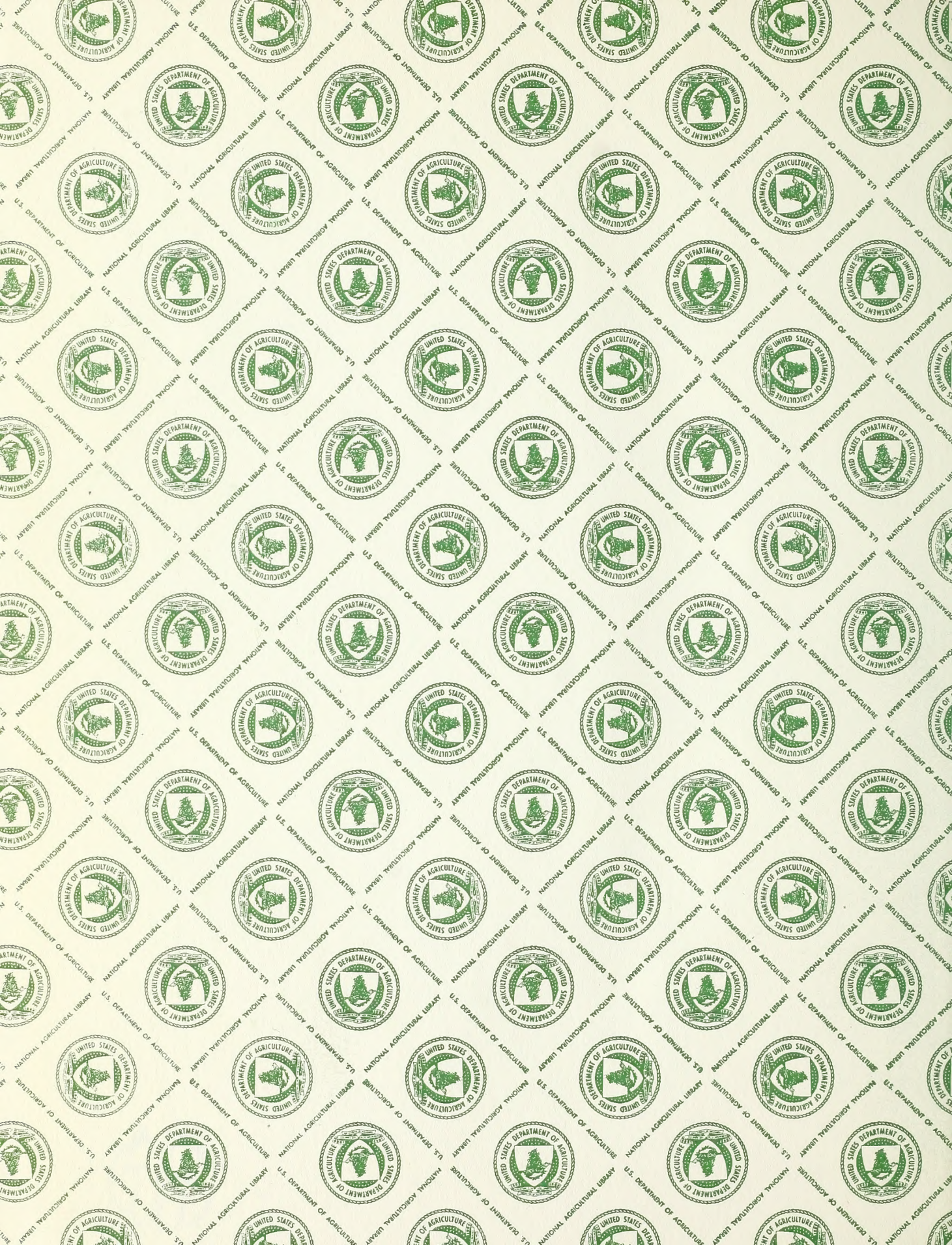
1953 x Lee (C.I. 13242)

Nine comparable quality tests of 1953 x Lee (C.I. 13242, B52-91) with Lee and Selkirk have been made, starting with the 1954 crop. 1953 x Lee was similar to Lee in a number of characteristics for which comparisons have been made. It was much like Lee in test weight, pearling index value, absorption, dough-mixing time, sedimentation value, flour yield, oxidation requirements, crumb color, and grain of bread. It was lower in protein content (wheat and flour 1.2 percent) and flour ash content (.06 percent) but higher in loaf volume than Lee. 1953 x Lee differed from Selkirk in only a few characteristics. It was higher in bushel weight (2.0 pounds) and required a slightly lower amount of oxidation for optimum bread than Selkirk. It was moderately strong in dough properties varying from mellow to strong for the different samples tested since 1954. It milled satisfactorily and was similar to the standard varieties in this respect. One favorable property was its somewhat lower ash content of the flour than either Lee or Selkirk.

Lathrop (C.I. 13457)

The recently named Wisconsin variety, Lathrop, a selection from the cross Henry[7] x P.I. 94587 (Wis. 253) was grown in 1959 and 1960 and was compared with three samples of Henry and six samples of Selkirk grown under comparable conditions. Lathrop had a higher bushel weight (0.9 pounds) and a lower absorption (2.0 percent) than the comparably-grown samples of Henry. The quality of the dough of Lathrop according to the mixograph tests was similar to that of Henry. The bread baking test by the remix method showed that both the crumb color and grain of the bread from Lathrop was better (10 points) than that in the bread made from Henry. Lathrop differs in a number of respects from Selkirk. It had a higher test weight per bushel (2.7 pounds) and flour yield (1.3 percent), but lower protein content (wheat 0.8 percent and flour 1.1 percent) and absorption (3.0 percent) than Selkirk. The bread from Lathrop was lower in loaf volume and internal crumb properties by both the regular and remix method than that from Selkirk. The quality of the dough according to the mixogram test showed that Lathrop had a reasonably

long development (mixing) time but a short mixing tolerance, the latter an objectionable property. Lathrop has shown very good to excellent milling properties. The dough handling properties at the time of panning have varied with a number of the samples showing mellow and sticky characteristics. The pearling index test, a measure of kernel hardness, indicated that Lathrop was a slightly softer wheat and not quite so hard in texture as the approved hard red spring wheats. It was similar to Henry in this respect.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